OPENING SESSION

Main Hall 07:45 – 08:20

07:45 Welcome and Medal Presentations
Michael E. Moseley, President

EIGHTH ANNUAL LAUTERBUR LECTURE

Main Hall 08:20 – 09:00 Chairs: Rolf Gruetter and Seiji Ogawa

08:20 From Immune Suppression to Mad Cow Disease – In Vitro NMR Spectroscopy with the Molecules of Life
Kurt Wüthrich
1ETH, Zürich, Switzerland

PLENARY LECTURES: MR Impact in Metabolomics and Proteomics

Main Hall 9:00 - 10:15 Chair: Sebastián Cerdán

9:00 1. From Genome to Metabolome
Kevin Brindle1
1University of Cambridge, Cambridge, UK

With the completion of a growing number of genome sequences attention is now turning to functional genomics, the elucidation of gene function from studies of the effects of gene modification on cellular phenotype. Magnetic resonance has an important role to play in this enterprise, from imaging changes in tissue morphology to spectroscopic measurements of changes in tissue biochemistry. This lecture will deal with MRS analysis of the small-molecule metabolite complement of the cell, the metabolome, and how this might be used, in conjunction with gene modification, to deduce gene function.

9:25 2. The Tumor Metabolome by MRS: Implications for Medical Diagnosis
John R. Griffiths1
1St. George’s Hospital Medical School, London, England, UK

Metabolomics, the youngest of the “-omics” sciences, is concerned with the totality of small molecules in an organism. NMR is attractive for investigating metabolic profiles, sub-sets of the metabolome, with minimal sample preparation. Metabolic profile studies are beginning on the effects of gene knockouts, inhibitions or overexpressions in cancer cells in culture as well as in experimental tumors. It is also possible to combine these data with conventional in vivo MRS studies of cancer in patients. Metabolomics can be used in drug discovery programs to indicate novel drug targets and to detect mechanisms of action or unwanted cellular side-effects.

9:50 3. MR-Based Metabonomic Approaches in Toxicology, Disease Diagnosis and Global Systems Biology
Jeremy K. Nicholson1
1Imperial College Faculty of Medicine, London, England, UK

Metabonomics involves the use of MRS and other spectroscopic tools to enable multivariate profiling of the integrated metabolic responses of complex systems to patho-physiological stress and disease. High frequency MRS can be applied to characterize a wide range of metabolites in biological fluids as spectra are changed characteristically in different toxicity or disease conditions. Pattern recognition analysis can give direct diagnostic information and aid the detection of novel biomarkers of disease. Novel methods of metabolic screening using probabilistic modelling approaches can now enable rapid toxicological and clinical assessments based on MRS of biofluids.
MR Angiography: New Techniques

Main Hall  11:00 - 13:00  
Chairs: James C. Carr and David Saloner

11:00  4.  
GCFP – A New Non-Invasive Non-Contrast Cine Angiography Technique Using Selective Excitation and Global Coherent Free Precession

Wolfgang G. Rehwald1, Igor Klem1, Anja Wagner1, Enn-Ling Chen1, Raymond J. Kim1, Robert M. Judd2
1Siemens Medical Systems, Durham, North Carolina, USA; 2Duke University, Durham, North Carolina, USA

We developed a new MR method based on a fundamentally new physical principle that produces dynamic images of blood flowing in the vascular bed. Unlike conventional MRA, the method delivers movies that are directly analogous to those obtained in x-ray angiography by visualizing vascular morphology and flow at the same time. However, the method requires neither ionizing radiation nor nephrotoxic contrast agents, and it is non-invasive. It relies on a previously not described state of global coherent free precession (GCFP) of magnetically prepared flowing blood that can be imaged while traveling through arteries and veins.

11:12  5.  
High Temporal and Spatial Resolution 3D Spiral MRA

H. Zhu1, Z. H. Zhang1, P. Wang1, H. L. Zhang2, V. A. Stenger1, D. G. Buck1, M. R. Prince2, Y. Wang1
1Univ. of Pittsburg, Pittsburgh, Pennsylvania, USA; 2Weill Medical College of Cornell University, New York City, New York, USA

The importance of time-resolved MRA is increasingly recognized because it simultaneously provides information about lumen anatomy and flow dynamics. Spiral imaging is inherently well suited to high temporal resolution MRA because it symmetrically over-samples the center of k-space for sliding window reconstruction and has an intrinsically short echo time for minimizing dephasing. Preliminary data show high quality time-resolved 3d spiral MRA.

11:24  6.  
Contrast-Enhanced MRA with Elliptic-Centric View Ordering and View Sharing: Theoretical Considerations and Application in Patients with Cardiopulmonary Disease

Christian Fink1, Michael Bock1, Randall Kroeker2, Martin Requardt2, Sebastian Ley1, Hans-Ulrich Kauczor1
1DKFZ, Heidelberg, Germany; 2Siemens Medical Solutions, Erlangen, Germany

Time-resolved contrast-enhanced 3D MRA of the pulmonary vessels has often been limited by a poor spatial resolution. In this study, a time-resolved 3D MRA protocol combining elliptic-centric view order with parallel imaging and a temporal interpolation scheme (TRICKS) offering a high spatial and temporal resolution was clinically assessed.

11:36  7.  
Temporally-resolved Pulmonary MRA with GRAPPA at 3 Tesla

James Carr1, Brian Schirf1, Nondas Leloudas1, Paul Nikolaidis1, Reed Omary1, Tim Carroll1
1Northwestern University Medical School, Chicago, Illinois, USA

3T whole body MRI scanners are becoming increasingly available and promise to produce at least 2-fold increases in SNR, particularly with respect to MRA. Therefore, SNR lost due to parallel imaging techniques should be regained at 3T. In this study, we successfully implemented temporally-resolved pulmonary MRA with GRAPPA at 3T using a higher imaging matrix to improve spatial resolution. When compared to a small patient group that had undergone MRA at 1.5T, 3T images demonstrated more detail and were of higher quality. MRA with parallel imaging may be more successfully implemented at 3T because of less marked reductions in SNR.

11:48  8.  
Undersampled Elliptical Centric View-ordering for Improved Resolution in Contrast-Enhanced MRA

Ananth Jayaseelan Madhuranthakam1, Houchun Harry Hu1, David G. Kruger1, Andrew V. Barger1, Stephen J. Riederer1
1Mayo Clinic College of Medicine, Rochester, Minnesota, USA

The application of elliptical centric (EC) view ordering to contrast-enhanced MR Angiography (CE-MRA) has been shown to provide high resolution angiograms without venous contamination. On the other hand, undersampled projection reconstruction (PR) also has advantages, such as robustness to undersampling artifacts and potentially improved spatial resolution. However PR can be sensitive to venous enhancement since it collects the center of k-space with every TR. In this work, we describe and test an EC view ordering in which undersampled PR techniques are applied to the periphery of the ky-kz phase encoding plane to provide further resolution improvement.
In this paper, a new method is presented which is designed to provide contrast-enhanced 3D high spatial resolution datasets at high temporal resolution. This method, CENTRA keyhole with SENSE, a central sphere is randomly acquired in kyk-space, repeated, and followed by an elliptical-centric readout of the periphery of k-space. Artifact-free results in the feet and in the brain are obtained with speedup factors of 30 and 45 respectively. CENTRA keyhole is a very useful technique to provide additional dynamic information while maintaining high spatial resolution.

The purpose of this study was to demonstrate a new projection contrast-enhanced technique for imaging coronary arteries. Five healthy volunteers were given a small (4 mL) injection of contrast agent and imaged using a 2D magnetization prepared thick slice imaging sequence with a sliding window reconstruction scheme. In all cases, the vessel of interest was well depicted and in three instances, branching was observed in the distal artery. The mean vessel length visible was 5.4 cm. Thick-slice projection imaging of coronary arteries is feasible and permits multiple contrast injections in a single study.

A combination IR/T2-prep 3D balanced SSFP sequence with square-spiral centric phase encode ordering is presented to produce high-resolution flow-independent angiograms in the presence of long-T1 fluids. The sequence employs phase-sensitive fat suppression, and achieves fluid-suppression with only a modest scan time penalty over normal SSFP. Results are presented in a normal foot. Excellent sinovial fluid suppression is demonstrated, enhancing the visibility of vasculature, and high arterial/venous contrast is achieved.

Non-contrast-enhanced SSFP angiography relies on differences in relaxation properties and chemical shift to differentiate arterial blood from surrounding muscle, fat and venous structures. Intermittent spectrally-selective pulses can be used to suppress fat signal. However, the additional time required reduces the acquisition efficiency and can disrupt the steady-state, potentially degrading arterial-venous contrast. A balanced-SSFP Dixon method robustly separates fat and water while maintaining the steady-state. Although the Dixon technique requires three acquisitions, the increased time is reflected in the resulting SNR, thus improving efficiency compared to the balanced SSFP sequence with intermittent fat suppression.

To minimize artifacts and background in cyclically IR-prepped SSFP contrast enhanced MRA, a view order is developed that acquires the center of k-space at minimal background signal and traverses k-space smoothly.
CLINICAL CATEGORICAL COURSE
Imaging in Drug Development

Room A  11:00 – 13:00  Chairs: Jeffrey L. Evelhoch and John R. Griffiths

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain why the pharmaceutical industry is incorporating imaging into the process of drug development;
• List at least two examples of how information provided from MR studies can impact the development of a drug;
• Describe what roles a practicing radiologist should play in imaging studies associated with clinical trials of new drugs.

Drug Development in Oncology
11:00  The Role of MR and Radiologists
       Patricia Cole

11:15  Current and Future MR Methods
       Geoff J.M. Parker

11:30  A Radiologist's Perspective
       Frederick Kelcz

11:45  Panel Discussion

Drug Development in Osteoarthritis
12:00  The Role of MR and Radiologists
       John C. Waterton

12:15  Current and Future MR Methods
       Garry E. Gold

12:30  Semiquantitative and Quantitative Imaging Techniques for Drug Discovery and Development in OA: A Radiologist's Perspective
       Philipp Lang

12:45  Panel Discussion

13:00  Adjournment

Brain Plasticity and Functional Morphology (MEMRI)

Annex 1  11:00 - 13:00  Chairs: A.M. van der Linden & Daniel H. Turnbull

11:00  Physiological Mapping of the Songbird Brain in Relation to their Seasonal Plasticity: Repeated Diffusion-, T2- and Brain Size Measurements
       Vincent Van Meir¹, Tineke Toussaint¹, Marleen Verhoye¹, Annemie Van der Linden¹
       ¹University of Antwerp, Antwerp, Belgium

Changes in brain size of adult warm blooded (endotherm) vertebrates are a rarely observed event under healthy conditions and in a short time window. We repeatedly examined the brain of free ranging female songbirds for changes in apparent diffusion, T2-values and brain size, within and after the breeding season. A dramatic decrease of 18% was found for the thalencephalon size. Evaluation of ADC and T2-values indicated a decrease in extracellular volume and cell size. This results indicate that seasonal brain plasticity in songbirds is not restricted to the well know plasticity of the song control system.
11:12 15. **Quantitative Characterization of Mouse Brain Development Using MR Microimaging and Large Deformation Metric**  
Jiangyang Zhang1, Michael J. Miller2, Paul Yarovksy3, Peter C. M. van Zijl4, Susumu Mori5  
1Johns Hopkins University, School of Medicine, Baltimore, Maryland, USA; 2Johns Hopkins University, Baltimore, Maryland, USA; 3University of Maryland, School of Medicine, Baltimore, Maryland, USA  

Diffusion tensor microimaging provide necessary resolution and contrast for quantitative study of mouse brain development. Global trend of embryonic mouse brain development and more detailed quantitative analysis of postnatal brain development were revealed by large deformation metric based on results of diffusion tensor microimaging.

11:24 16. **Magnetization Transfer MRI of Mouse Brain Reveals Areas of High Neural Density**  
Oliver Natt1, Takashi Watanabe1, Susann Boretius1, Jens Frahm1, Thomas Michaelis1  
1Biomedizinische NMR Forschungs GmbH am Max-Planck-Institut für biophysikalische Chemie, Göttingen, Germany  

Extending applications of magnetization transfer contrast (MTC) in magnetic resonance imaging of the human central nervous system, this work quantitatively describes MTC of the murine brain. As a novel finding, complementing T1- and T2-weighted MRI, MTC allows for the distinction of densely packed gray matter from normal gray and white matter. Examples include the Purkinje cell layer and the granular cell layer in the mouse cerebellum as well as the delineation of the CA3 subfield of the hippocampus relative to surrounding hippocampal gray matter and white matter tracts such as the hippocampal fimbria.

11:36 17. **In Vivo Quantitative Tract Tracing with Manganese Enhanced MRI**  
Lorin John Freedman1, Xiaodong Zhang1, Changjun Shi1, Michael Davis1, Xiaoping Hu1  
1Emory University, Atlanta, Georgia, USA  

Manganese enhanced MRI takes advantage of the anterograde transport of Mn in the central nervous system, as well as its paramagnetic properties, which cause enhancement in T1-weighted images. In addition, because the change in the longitudinal relaxation rate is proportional to the concentration of Mn, it is possible to quantify the amount of Mn transported to different targets. This work provides experimental evidence of this potential for quantitative measurement in the rat. Our results demonstrate the feasibility of quantitative assessment of neuronal connectivity using Mn transport and its invariance with neuronal firing.

11:48 18. **Contrast Enhancement as a Function of Time and Dose after Intravenous MnCl2 Administration using High Resolution Manganese Enhanced MRI (MEMRI) of Mouse Brain**  
Jung Hee Lee1, Afonso C. Silva1, Hellmut Merkle1, Alan P. Koretsky1  
1National Institutes of Health, Bethesda, Maryland, USA  

Manganese-Enhanced MRI (MEMRI) is a technique that has proven useful for visualization of brain activity, neuroarchitecture, and connectivity. Full advantage of such properties of MEMRI can only be achieved with broad understanding of the several selective uptake processes as well as the distribution mechanism of Mn2+ throughout the brain as a function of time and dose. We evaluated the relationship between the dose of intravenously administered MnCl2 and the resulting changes in contrast enhancement and T1 values in various regions of the mouse brain. We also investigated the time course of Mn2+ uptake and its distribution throughout the brain.

12:00 19. **Pharmacological Activity-Induced Manganese Dependent Contrast (PhAIM) MRI - Detection of Neurotransmitter-Induced Neuronal Activity**  
Ichio Aoki1, Yi-Jen Lin Wu1, Yuki Morii1, Masahiro Umeda1, Alan P. Koretsky1, Chuzo Tanaka1  
1Meiji University of Oriental Medicine, Hiyoshi, Kyoto, Japan; 2Carnegie Mellon University, Pittsburgh, Pennsylvania, USA; 3National Institutes of Health, Bethesda, Maryland, USA  

BOLD can be used to investigate brain activity associated with the administration of CNS-active drugs, a technique referred to as phMRI. Recently, AIM MRI was introduced as being independent of hemodynamic changes. The goal of this study is to produce new neurotransmitter-sensitivity dependent contrast MRI (phAIM). Neurotransmitter induced brain activity mapping was successfully performed with phAIM MRI using dopamine, kainic acid, and norepinephrine. There was a 230% increase in signal intensity in the hypothalamus after dopamine administration. These results indicate that phAIM provides a new brain mapping tool reflecting pharmacological induced neural activity and should be applicable to many substances.

12:12 20. **In Vivo Tracking of Axonal Disruption and Recovery in the Rat Olfactory System by MnCl2 Enhanced MR Statistical Maps**  
Donna J. Cross1, Yoshimi Anzai1, Kenneth R. Maravilla1, Thomas J. Morrow1, Jennifer A. Flexman1, Sosuke Miyoshi1, Satoshi Minoshima1  
1University of Washington, Seattle, Washington, USA; 2Ann Arbor VA Hospital, Ann Arbor, Michigan, USA  

Functional connections of rat olfactory system were mapped in vivo using manganese (MnCl2) enhanced sequential 3D-SPGR MR imaging and group-averaged stereotactic statistical mapping. Significant Mn transport was seen in common olfactory structures such as bulb, tract, tubercle and piriform cortex as well as finer structures such as anterior commissure. Technique was then applied to investigate reorganization of neuronal connectivity after stereotactic radiofrequency lesioning in the olfactory tract. Initial disruption of ipsilateral transport at 1 week post-lesion recovered significantly at 4 weeks with additional transport to the contralateral pathway through commissural fibers, indicating possible two different modes of reorganization in vivo.
Visualization of Cortical Spreading Depression Using Manganese-Enhanced MRI
Erica C. Henning\textsuperscript{1}, Xiangjun Meng\textsuperscript{2}, Marc Fisher\textsuperscript{2}, Christopher H. Sotak\textsuperscript{2}
\textsuperscript{1}Worcester Polytechnic Institute, Worcester, Massachusetts, USA; \textsuperscript{2}University of Massachusetts Memorial Healthcare, Worcester, Massachusetts, USA

Cortical spreading depression (CSD) was visualized for the first time using manganese-enhanced MRI (MEMRI) following topical application of 4M KCl to the exposed rat cortex. The region of MEMRI signal enhancement was confined to a 1.0-1.5-mm-thick cortical layer extending radially from the induction site. MEMRI allowed visualization of CSD over the entire cortical layer in the affected hemisphere. These results are consistent with previous studies of CSD using DWI and should be useful for investigating CSD itself as well as its role in cerebral ischemia.

Detection of Neural Damage in the Hippocampus CA1 Region using Manganese Enhanced MRI (MEMRI) in a Cardiac Arrest Model
Ichio Aoki\textsuperscript{1}, Yuki Mori\textsuperscript{1}, Masahiro Umeda\textsuperscript{1}, Toshihiko Ebisu\textsuperscript{1}, Masaki Fukunaga\textsuperscript{1}, Shoji Naruse\textsuperscript{4}, Chuzo Tanaka\textsuperscript{1}
\textsuperscript{1}Meiji University of Oriental Medicine, Hiyoshi, Kyoto, Japan; \textsuperscript{2}Nantan Hospital, Yagi, Kyoto, Japan; \textsuperscript{3}National Institutes of Health, Bethesda, Maryland, USA; \textsuperscript{4}Kyoto Prefectural University of Medicine, Kyoto, Japan

Global ischemia causes neuronal death in the vulnerable CA1 region of the hippocampus. However, hippocampus has been difficult to visualize in-vivo because the structure is complicated and no specific contrast. We investigated the hypothesis that transient cardiac arrest using β-blocker would alter MEMRI enhancement due to neuronal damage in the hippocampus. There were two major findings: 1) Signal was not enhanced significantly in the CA1 region on the MEMRI. 2) Histopathologic neural damage was observed at CA1 region. MEMRI can provide visualization of the hippocampus and furthermore MEMRI is sensitive to hippocampal neuronal damage.

Is the Habenula the Key Nucleus Linking Emotional and Motor Impairments in Parkinson’s Disease?
Galit Pelled\textsuperscript{1}, Hagai Bergman\textsuperscript{2}, Tamir Ben-Hur\textsuperscript{1}, Gadi Goelman\textsuperscript{1}
\textsuperscript{1}Hadassah Hebrew University Hospital, Jerusalem, Israel; \textsuperscript{2}Hadassah Medical School, Jerusalem, Israel

A large percentage of Parkinson’s disease (PD) patients exhibit emotional and psychiatric deficits that are thought to be related to the limbic areas, in addition to motor impairments. In order to investigate the functional connectivity between the limbic and the Basal Ganglia (BG) systems, manganese chloride was injected directly into several nuclei in the 6-OHDA PD model rats and sham-operated rats, and Manganese-Enhanced MRI was used to detect the manganese transport within the brain. The results show the fundamental role the Habenula nuclei plays in PD, presumably as the key nuclei, linking between the BG and the limbic system.

$^{13}$C ($^1$H) MRS of Cerebral Physiology and Pathology
Sakura

Ultra-Fast In Vivo Measurement of CMRO$_2$ in Rat Brain in Seconds: A 17O NMR Study at 9.4 Tesla
Xiao-Hong Zhu\textsuperscript{1}, Yi Zhang\textsuperscript{1}, Nanyin Zhang\textsuperscript{1}, Kamil Ugurbil\textsuperscript{1}, Wei Chen\textsuperscript{1}
\textsuperscript{1}University of Minnesota, Minneapolis, Minnesota, USA

The determination of the cerebral metabolic rate of oxygen utilization (CMRO$_2$) is essential for understanding the central role of oxidative metabolism in brain function under physiological and pathological states. The simplest MR method for measuring CMRO$_2$ is the use of $^{17}$O MRS to detect the labeled H$_2^{17}$O, which is metabolized from inhaled $^{17}$O$_2$. It has been demonstrated that high-field $^{15}$O MRS is capable of obtaining 3D CMRO$_2$ maps in rat brain during 2 minutes of $^{15}$O$_2$ inhalation. In this work, we explored the feasibility for ultra-fast measurements of CMRO$_2$ in rat with a temporal resolution of seconds at 9.4T.
11:12  **Assessment of the Energetics of Glutamatergic and GABAergic Neurotransmission in Rat Cortex during Postnatal Development**

Golam M I Chowdhury¹, Anant B. Patel¹, Douglas L. Rothman¹, Kevin L. Behar¹

¹Yale University School of Medicine, New Haven, Connecticut, USA

The objective of this study was to quantify fluxes of glutamatergic and GABAergic neurotransmission and energetics in 10 day old and 30 day old rat cortex. Metabolic fluxes were determined ¹³C-enrichment time courses of glutamate, GABA and glutamine measured ex vivo following timed infusions of either [1,6-¹³C₂]glucose or [2-¹³C]acetate. The neurotransmitter cycling-to-neuronal glucose oxidation ratios (Vcycle/VTCA) for glutamatergic and GABAergic neurons were similar for the two postnatal ages, despite a large (>4x) and proportional change in their respective absolute neurotransmitter cycle and TCA cycle fluxes. Our findings indicate that both neurotransmitter cycles are tightly coupled to energetics during postnatal development.

11:24  **Increased Inhibitory Neurotransmission Observed During Intense Neuronal Activation in Rat Cortex: An Ex Vivo ¹³C NMR Study**

Anant B. Patel¹, Robin A. de Graaf¹, Graeme F. Mason¹, Douglas L. Rothman¹, Robert G. Shulman¹, Kevin L. Behar¹

¹Yale University School of Medicine, New Haven, Connecticut, USA

The objective of this study was to evaluate the relationship between inhibitory and excitatory neurotransmission during intense neuronal activation. We have used ¹³C NMR spectroscopy together with infusion of ¹³C labeled glucose and acetate to determine the metabolic flux under baseline (halothane anesthesia) and bicuculline-induced seizures. Both glucose oxidation and glutamatergic and GABAergic neurotransmitter fluxes were increased during bicuculline-induced seizures, indicating that neurotransmission and energy consumption by inhibitory synapses also increased with increasing cortical activity.

11:36  **In Vivo ¹³C NMR Measurement of Activity-Dependent Malate-Aspartate Shuttle Flux in the Brain**

Pierre-Gilles Henry¹, Kamil Ugurbil², Rolf Gruetter²

¹University of Minnesota, Minneapolis, Minnesota, USA

It has been proposed that the apparent exchange rate, Vx, between mitochondrial 2-oxoglutarate and cytosolic glutamate may depend on the activity of the malate-aspartate shuttle and thus on cerebral energy status. In this study, label incorporation into cytosolic amino acids from ¹³C-labeled glucose was measured in localized volumes in the rat brain under three different anesthetic conditions. By fitting a two-TCA cycle model, Vx was found to highly correlate with neuronal TCA cycle flux (r=0.99, p<0.01). We conclude that Vx depends on neuronal activity and that the malate-aspartate shuttle flux can be measured in the brain in vivo.

11:48  **In Vivo ¹H-[¹³C] NMR Spectroscopy of Cerebral GABA Turnover**

Pieter van Eijsden¹, Kevin L. Behar², Robin A. de Graaf²

¹University Medical Center Utrecht, Utrecht, Netherlands; ²Yale University School of Medicine, New Haven, Connecticut, USA

¹H-[¹³C] MRS is a powerful tool to reliably measure the TCA cycle rate and turnover rates of glutamate, glutamine and several other important metabolites. Unfortunately, GABA turnover in vivo has remained below detection threshold. At 9.4 T, however, this turnover can be observed dynamically and in vivo. This provides us with the means to measure glutamatergic (excitatory) and GABAergic (inhibitory) neurotransmitter metabolism simultaneously, allowing further investigation of the coupling between cerebral energy metabolism and neuronal activation or research of pathological conditions involving GABAergic neurotransmission.

12:00  **Transgenic Knock-Out Mice in D1 Dopamine Receptors Have Increased Glutamine Cycle Activity as Detected by ¹³C NMR**

Tiago Brandao Rodrigues¹, A B. Martin¹, Patricia Sanchez¹, Alejandra Sierra¹, Carlos Geraldes², Paloma Ballestros¹, Sebastian Cerdan¹, Rosario Moratalla¹

¹CSIC, Madrid, Spain; ²University of Coimbra, Coimbra, Portugal; ³UNED, Madrid, Spain

Dopaminergic activity is modulated by the primary stimulatory dopamine receptor-type D1, which plays an important role in the physiopathology of Parkinson disease and some types of drug addiction (e.g. cocaine). Here we report on the interactions between dopaminergic and glutamatergic neurotransmissions using transgenic knock-out mice deficient in the dopamine D1 receptor. We infused (1,2-¹³C₂) acetate, a glial substrate, in wild type and KO mice and analyzed by ¹³C NMR extracts obtained at the end of the infusion. Our results show that removal of D1 dopaminergic receptors is associated to a compensatory increase in cerebral glutamine synthesis and glutamine cycle flux.
12:12 30. Neurochemical Profile of the Hibernating Ground Squirrel Measured by 1H NMR Spectroscopy


1University of Minnesota, Minneapolis, Minnesota, USA; 2University of Minnesota, Duluth, Minnesota, USA

It is unclear what neuroprotective mechanisms are present to prevent brain damage during hibernation. The goal of this study was to measure metabolite concentrations by 1H NMR spectroscopy in active and hibernating ground squirrels. We demonstrate the feasibility of detecting resolved 1H NMR spectra in the brain at 5°C and evaluate the impact of low temperature on quantitation using LCModel. The PCr/Cr ratio and GABA concentration were significantly elevated in hibernating animals, reflecting changes in energy status and inhibitory neurotransmitter metabolism.

12:24 31. Synergistic Effects of Ammonia and Manganese on Brain Cell Metabolism

Touraj Shokati1, Claudia Zwingmann2, Alan Hazell2, Dieter Leibfritz1

1University of Bremen, Bremen, Germany; 2University of Montreal, Montreal, Quebec, Canada

Similarities between chronic hepatic encephalopathy (HE) and manganese toxicity suggest the involvement of manganese in the pathogenesis of HE. The aim of the present study was to investigate the metabolic response in cultured brain cells (primary astrocytes, neurons and co-cultures) treated with manganese and/or ammonia by means of multinuclear NMR spectroscopy. The data show that ammonia and manganese act in a synergistic way to alter brain cell metabolism. While neurons are particularly sensitive to developing massive energy failure after concomitant incubation with ammonia and manganese, manganese plays a major role in stimulating a protective astrocytic response against mitochondrial energy failure.

12:36 32. In Vivo CSI of Glutamate in the Monkey Brain

Christoph Juchem1, Hellmut Merkle1, Nikos K. Logothetis1, Josef Pfeuffer1

1Max Planck Institut für Biologische Kybernetik, Tübingen, Germany; 2National Institutes of Health, Bethesda, Maryland, USA

CSI studies of metabolites in the human brain typically suffer from poor spatial resolution or they are restricted to substances with strong peaks that are visible at longer echo times. In this study, enhanced spectral dispersion and sensitivity at high field in combination with short echo times was utilized to measure a pure glutamate map in the ventricle region of the manlike monkey model (Macaca mulatta), instead of a sum of glutamate and glutamine. In addition, first CSI results in the occipital lobe are presented with a high spatial resolution in the millimeter range.

12:48 33. 1H Spectroscopic Imaging Determines Immunotherapeutic Efficacy in a Murine Model of Parkinson's Disease

Michael D. Boska1, Eric J. Benner1, Jay A. Nelson1, R Lee Mosley1, Travis B. Lewis1, Mariano Uberti1, Melissa L. Mellon1, Howard E. Gendelman1

1University of Nebraska Medical Center, Omaha, Nebraska, USA

Degeneration of dopaminergic neurons in the substantia nigra pars compacta (SNpc) and termini in the striatum are pathological hallmarks of Parkinson's disease (PD). Utilizing the 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) model of human PD, we demonstrated that adoptive transfer of spleen cells (splenocytes) from Copaxone (Cop-1) immunized donors elicits significant neuronal protection. In the current work, quantitative proton spectroscopic imaging (1H MRSI) demonstrated reduced NAA concentrations in SNpc of MPTP treated mice compared to control (saline treated) mice. NAA concentrations were maintained in MPTP treated mice that received Cop-1 immune splenocytes.

Novel RF Coil Arrays and Other Innovations

Annex 2 11:00 - 13:00 Chair: Steven M. Wright and Hiroyuki Fujita

11:00 34. A Focused MRI with Coupled Phased Array at 7T

Ray F. Lee1, Christopher M. Foresto1

1New York University, New York, USA

Inhomogeneous RF excitation in 7T MRI is due to not only “dielectric resonance” but also coil placement. An analysis and FDTD simulation demonstrate that by manipulating the amplitudes/phases of port-voltages in a volume strip array during transmit, the brightened region can be shifted to a specified location, which may suggest a focused MRI.
11:12 Numerical Comparison Between TEM Head Coil and Birdcage Head Coil at 7T
Gordon D. DeMeester1, Zhiyong Zhai1, Michael A. Morich1, Christoph Leussler2, Christian Findeklee2
1Philips Medical Systems, Cleveland, Ohio, USA; 2Philips Research Laboratories, Hamburg, Germany

A TEM T/R head coil and a shielded birdcage T/R head coil operated at 298MHz/7T were both modeled using the Finite Difference Time Domain (FDTD) method. The two coils have approximately the same physical size. B1-field and SAR were calculated for the two head coils loaded with a realistic human head model. B1-field comparison shows a slightly better B1-field uniformity inside the head for the birdcage coil design. SAR comparison shows, that for the same average B1-field strength over the center slice of the head, the birdcage head coil gives lower head and local SAR.

11:24 An 8 Channel Phased Array Coil and Detunable TEM Transmit Coil for 7 T Brain Imaging
Graham Charles Wiggins1, Christina Triantafyllou1, Andreas Potthast2, Christopher John Wiggins1, Lawrence L. Wald1
1Massachusetts General Hospital, Charlestown, Massachusetts, USA; 2Siemens Medical Solutions, Erlangen, Germany

The advantages of phased array receive coils are well established in MR imaging, and are expected to become greater at higher frequency due to increased tissue loading and radiative losses. There are however various challenges in their design and use at fields of 7 Tesla and higher. We present a flexible 8 channel phased array coil and detunable TEM transmit coil for 7 T. The SNR gain provided by the phased array compared to a standard TEM volume coil ranged from 6 fold at the outside of the brain to 1.2 fold in the center of the head.

11:36 Dual-Coverage T/R Phased Array Coil for Knee Imaging at 1.5T Tesla
Tsinghua Zheng1, Shuren Zhao1, Robert Anderson1, Labros Petropoulos1
1USA Instruments, Inc., Aurora, Ohio, USA

A T/R phased array coil for knee imaging at 1.5 Tesla was constructed and tested. The coil uses a quadrature birdcage coil to transmit and an array of six dual-coverage surface coils to receive signal. Each coil in the array is critically coupled to its neighboring coils to minimize the interaction. The dual-coverage coil has two working modes: The full mode that has S/I coverage of 16cm for normal knee imaging and the zoom mode with S/I coverage of 10cm for high-resolution knee imaging.

11:48 Improved Excitation Homogeneity at High Frequencies with RF Pulses of Time Varying Spatial Characteristics
Patrick Joseph Ledden1, Yuan Cheng1
1Nova Medical, Inc., Wakefield, Massachusetts, USA

This work shows the feasibility of generating substantially improved spin excitation at high frequencies by the use of a transmit field of time varying spatial characteristic consisting of two separate pulses with different field distributions. Computationally we demonstrate that two different spatially optimized pulses at 7T improve excitation homogeneity in a human head model by more than four fold compared with standard volume coil excitation.

12:00 Design of a Coil Array for Mouse Imaging at 14.1 T
Xiaozhong Zhang1, Andrew G. Webb1
1University of Illinois at Urbana-Champaign, Urbana, Illinois, USA

Phased array coils provide high SNR and the capability of utilizing partial parallel acquisition methods for high speed MRI. To date no designs have been presented at the very high magnetic fields used for MR microscopy. A probe consisting of a large transmit surface coil and four phased array receive coils was constructed for operation at 14.1 T (600 MHz). The array has an input impedance of 50 Ω, and variable capacitors were used to minimize coupling between arrayed coil pairs without introducing significant loss. High-resolution 2D images of the spinal cord of a mouse have been acquired.

12:12 The SNR of Spiral Birdcage Coils
Timothy Taves1, Laura Kasian1, Scott B. King1
1National Research Council of Canada, Winnipeg, Manitoba, Canada

Recently, a new type of volume phased array was proposed, using volume coils with substantially orthogonal fields such as spiral birdcages. A coil-center SNR comparison of simulated and constructed standard and spiral birdcage head coils, found that spiral birdcage SNR was lower by factors of 0.80, 0.62, 0.46, 0.12 for twists of ±π, ±2π, ±3π, ±4π respectively relative to a standard untwisted-birdcage. The SNR loss at coil center for higher order spiral coils suggests that gains in SNR over comparable length standard birdcage coils would be limited to 30%.
12:24 41. Current Sheet Antenna Array - A Transmit/Receive Surface Coil Array for MRI at High Fields

Sven Junge, Frank Seifert, Gerd Wuebbeler, Herbert Rinneberg
1Bruker BioSpin MRI GmbH, Ettlingen, Germany; 2Physikalisch-Technische Bundesanstalt, Berlin, Germany

A novel transmit receive coil array particularly suitable for MRI at high fields is presented. The coil array elements are based on so-called current sheet antennas (CSA). The absence of the normal component of the electrical field and additional shielding of the electrical field yields in a surface coil excellently performing for MRI imaging at high fields. The use of independently driven elements of coil arrays for manipulating the homogeneity of the transverse RF-field becomes more important with increasing magnetic fields. First results are shown with a 4-channel array for head coil imaging at 3T driven by independent transmitters.

12:36 42. Improvement in SNR at 3T Using a LN2 Cooled Copper RF Coil

Jolinda C. Smith, Ray L. Nunnally
1University of Oregon, Eugene, Oregon, USA

An inductively coupled 25 mm octagonal coil and vacuum insulated dewar were built and interfaced to a 3T system. The SNR gain was 4-5 to 1 for the identical imaging sequence compared to the room temperature version of the same coil. Initial results obtained from small fish (sticklebacks) and live C57BL mice are shown. In-plane image resolutions of 140 microns and slice thicknesses of 0.5 to 1 mm for 2D T2-W and PD images having 26 slices were achieved with scan times of 12 minutes or less. Cryo-cooled copper coils are simple to build and use.

12:48 43. Metamaterial Yoke for Signal Reception- An Initial Investigation

Michael CK Wiltshire, R Mark Henkelman, Ian R. Young, Joseph V. Hajnal
1Hammersmith Hospital, Imperial College London, London, UK; 2Hospital for Sick Children, Toronto, Ontario, Canada

The concept of a magnetic yoke to provide a low reluctance path that assists in achieving a desirable pattern of flux linkage is well established for static fields. We investigated a yoke for radio-frequency magnetic fields that exploits NMR compatible metamaterials, which have a high magnetic permeability at a chosen frequency, but little effect on B0. A simple test yoke was compared to a linear configuration of metamaterial and shown to have a strong flux ducting effect that resulted in a small increase in coupling from source to receiver coil. Material losses were probably the most significant limiting factor.

**Physiology of Brain Activation**

Room D 11:00 - 13:00 Chairs: Rasmus M. Birn and Eric C. Wong

11:00 44. Contrast Adaptation in Human Early Visual Cortex as Measured with Event Related Bold Imaging

Justin L. Gardner, Pei Sun, R. Allen Waggoner, Ken Ueno, Keiji Tanaka, Kang Cheng
1RIKEN Brain Science Institute, Wakoshi, Japan

We have used event-related BOLD imaging to ask how adaptation to the contrast of a visual stimulus changes contrast response functions of early human visual areas. Contrast-response curves were constructed from BOLD signal changes to brief changes in stimulus contrast from three different contrast adaptation levels. Adaptation resulted in primarily horizontal shifts of contrast response curves. We unexpectedly found that while early visual areas show transient decreases in BOLD signal to decreases in stimulus contrast, V4v predominantly shows increases in BOLD response to both contrast increases and decreases. This suggests that V4v encodes stimulus salience rather than faithfully representing contrast.

11:12 45. Dynamic Update of R2* and Field Map in fMRI

Valur Olafsson, Jeffrey A. Fessler, Douglas C. Noll
1University of Michigan, Ann Arbor, Michigan, USA

A framework where the R2* map and the field map are dynamically updated using estimates of incremental changes in the maps between neighboring time points in an fMRI time series is introduced. The estimation problem can be solved using fast iterative algorithms, by linearizing the difference signal of these neighboring time points. This framework is then applied for a study of motor activation using a finger tapping task. The dynamically updated R2* was shown to detect the task waveform and the dynamically updated field map was shown to capture respiration and field drifts.

11:24 46. Measuring Blood Oxygenation at 2.35T using a Multi-Echo Sequence

A G. Gardener, P A. Gowland, S T. Francis
1University of Nottingham, Nottingham, UK

The oxygenation, haematocrit and echo time dependence of apparent blood T2 relaxation have been investigated in order to develop a method of separating arterial and venous blood volume changes that occur during neuronal activation. Experimental data acquired at 2.35T has been used to determine different parameters used to describe blood T2. The data has subsequently been fitted to three proposed exchange and diffusion models. The results do not show a significant preference for a particular model.
**Quantifying the Intravascular SE BOLD Effect at 1.5T**

Bojana Stefanovic¹, G. Bruce Pike²

¹Montreal Neurological Institute, Montreal, Quebec, Canada

Human whole blood relaxometry was performed at 1.5T to quantify intravascular BOLD signal changes and examine the mechanism underlying R2 enhancement in blood upon partial deoxygenation. A range of blood oxygen saturation levels (Y), pertinent to functional physiology, was achieved through an exercise paradigm. Ensemble fitting of the entire set of T2 estimates, at various Y and refocusing intervals, was performed using both the fast chemical exchange model and the model of diffusion in weak magnetic field inhomogeneities. The current findings support the diffusion model of R2 enhancement in blood at 1.5T and allow SE IV BOLD quantification.

**Acute Serotonergic Modulation of Neuronal Responses to Implicit Recognition of Facial Expressions, Behavioural Inhibition and Reinforcement**

Cristina Del Ben¹, Shane McKie¹, Steve Williams³, Ian Anderson¹, Paul Richardson¹, Rebecca Elliott¹, Mairead Dolan¹, Bill Deakin¹

¹Manchester University, Manchester, UK

Serotonin (5-HT) is believed to play a role in many neuropsychological processes. We used BOLD fMRI to assess the effects of the selective serotonin reuptake inhibitor citalopram on brain activation during behavioural inhibition, reinforcement and facial emotion processing. We hypothesised that citalopram will modulate facial emotion processing, attenuating the response to negative emotions, and will enhance neuronal activation induced by behavioural inhibition and reinforcement. The results supported the hypothesis that 5-HT critically modulates incidental responses to emotional stimuli at a neuronal level, and that a role in behavioural inhibition and modulates areas previously indicated to be involved in reward processing.

**Imaging Cocaine-Induced Changes in BOLD, CBF and Oxygen Consumption**

Zhaohui M. Liu¹, Qiang Shen¹, Kenneth M. Sicard¹, Marcelo Febo², Craig F. Ferris³, Elliot A. Stein², Timothy Q. Duong³

¹University of Massachusetts Medical School, Worcester, Massachusetts, USA; ²National Institutes of Health, Baltimore, Maryland, USA

Pharmacological fMRI of cocaine based on the BOLD technique could potentially pose several problems. The non-neural effects that could arise from cocaine-induced changes in respiration and heart rate, blood pressure and vasoconstriction could markedly affect the BOLD signal, independent of the cocaine-evoked increase in neural activity because the BOLD signal is highly dependent on the underlying physiology. Herein, cerebral metabolic rate of oxygen (CMRO2) fMRI was used to deconvolve the non-neural effect of cocaine. Simultaneous BOLD and CBF were measured using the continuous arterial spin-labeling technique with multislice echo-planar imaging. CMRO2 was calculated pixel-by-pixel using Davis’s biophysical BOLD model.

**Using Simultaneous EEG Recording to Test the Feasibility of Directly Detecting Neuronal Currents Due to Alpha Wave Activity By MRI**

Sean Adam Leach¹, Khalid Hamandi², Louis Lemieux², Penny Gowland¹, Philip Allen¹, Richard Bowtell¹

¹University of Nottingham, Nottingham, UK; ²Institute of Neurology, Chalfont St Peter, Buckinghamshire, UK; ³National Hospital for Neurology and Neurosurgery, London, UK

An experiment to assess the feasibility of detecting the neuronal currents associated with alpha wave activity in MRI phase images is described. A previous study has shown that alpha wave activity should be detectable in EPI phase images. In this study EEG recordings have been made while simultaneously collecting EPI images of the occipital lobe at a rate of 25 images per second. Significant correlation of the power modulation in the alpha band of the EEG and of image phase timecourses has been observed in clusters of voxels in some subjects.

**Improved fMRI Artifact Reduction from Simultaneously Acquired EEG Data Using Slice Dependent Template Matching**

Rami K. Niazy¹, Giandomenico Iannetti¹, Christian F. Beckmann¹, Michael Brady¹, Stephen M. Smith¹

¹University of Oxford, Oxford, UK

Simultaneous acquisition of EEG and fMRI has promising applications in many clinical and research areas. A difficulty with this technique is that EEG data collected during fMRI acquisition is severely contaminated due to the changes in magnetic field induced by scanner gradients. An fMRI Artifact Slice Template Removal (FASTR) algorithm is presented, in which significant improvements are achieved over the most widely used method today of Imaging Artifact Reduction (IAR) using subtraction of an average artifact.
New Processing Methods for Magnetoencephalographic (MEG) Data Reveal Neuronal Correlates to the BOLD Response

Matthew J. Brookes¹, Andrew M. Gibson¹, Stephen D. Hall², Paul L. Furlong², Arjan Hillebrand², Krish D. Singh², Ian E. Holliday², Sue Francis¹, Peter G. Morris¹
¹University of Nottingham, Nottingham, UK; ²Aston University, Birmingham, UK

It has previously been shown that the spatial distribution of loss of electrical oscillatory power in a given frequency band is spatially coincident with the fMRI BOLD response. This is consistent with the view that loss of cortical oscillatory power is accompanied by increased non phase-locked electrical activity. Here we combine the formalism of the General Linear Model to MEG beamformer technology to create a technique that may reveal further possible neuronal correlates to the BOLD response. In particular we follow up previous ideas that a correlation between increased energy demand and a sustained electrical response exists.

Using EEG/fMRI and Connectivity Analysis to Define Epileptogenic ‘Circuits’

Graeme D. Jackson¹, Anthony B. Waites¹, David F. Abbott¹, Angelo Labate¹, Regula S. Briellmann¹
¹Brain Research Institute, Melbourne, Australia

Recording of brain generated electrical potentials (EEG) inside the MRI has enabled the BOLD signal associated with epileptogenic ‘events’ to be analysed. In this study we found that spikes with different appearances in the EEG and in the associated BOLD activation, appear to be part of a near identical and widespread network not present in normal individuals. These data support the idea that interictal epileptiform events are an expression of activity in an epileptogenic network rather than activation in a local and isolated part of the brain. Connectivity analysis may give new insights into the biology that underlies seizure generation.

Uterine and Fetal MR Imaging

Room B-1  11:00 - 13:00  Chairs: Kaori Togashi and Margaret A. Hall-Craggs

Oral Contraceptives and Uterine Peristalsis: Evaluation with MRI

Aki Kido¹, Kaori Togashi¹, Asako Nakai¹, Milliam Lika Kataoka¹, Takashi Koyama¹, Shingo Fujii¹
¹Kyoto University, Kyoto City, Kyoto, Japan

To analyze the effects of oral contraceptives (OCs) on the mid-cycle uterus, 30 female volunteers of whom 15 were taking OCs and 15 were not, were evaluated using static and cine MR imaging. Uterine peristalsis, which is defined as a subtle contraction surging at the myometrial-endometrial junction, was remarkably suppressed in OCs. The static images in OC users showed a thinner junctional zone and a thicker myometrium. A strong correlation between suppressed peristalsis and estrogen with intake of OCs will be hypothesized in that an inhibition of waves may be caused by OCs and possibly disturb upward transport of sperm.

A Hypointense Area Near the Sacral Promontorium Seen in Patients with a Huge Leiomyoma and Adenomyosis of the Uterus on Contrast-Enhanced T1-Weighted MR Imaging

Kensuke Uotani¹, Shuichi Monzawa¹, Shuji Adachi¹, Masayuki Takemori¹, Yasushi Kaji¹, Kazuro Sugimura¹
¹Kasai Municipal Hospital, Kasai, Hyogo, Japan; ²Hyogo Medical Center for Adults, Akashi, Hyogo, Japan; ³Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan

In nine patients with huge leiomyoma and two with adenomyosis of the uterus, a curious hypointense area was observed at the dorsal portion near the sacral promontorium in an enlarged uterus on contrast-enhanced T1-weighted MR images. The areas showed flare shape in the nine patients with leiomyoma, and nodular shape in the two with adenomyosis. T1- and T2-weighted MR images showed no signal abnormalities at the site corresponding to the hypointense areas in all eleven patients. Pathological examination performed in two patients showed no specific findings. These areas might represent functional changes caused by compression of the promontorium.

MR Imaging of Adenomyosis: Changes with Uterine Artery Embolization

Yuri Kitamura¹, Reena C. Jha¹, Sandra J. Allison¹, James B. Spies¹, Susan M. Ascher¹
¹Georgetown University Hospital, Washington, District of Columbia, USA

Sixteen women with adenomyosis were imaged with MRI before and after UAE. There was 24% decrease in uterine volume and 11 of 16 patients showed areas of devascularization within the adenomyosis. The junctional zone and junctional zone/myometrial ratio did not change significantly after UAE. All patients reported improvement in clinical symptoms. MRI is able to image changes in adenomyosis following UAE.
57. Real-time SSFSE Imaging of the Fetus
Deborah Levine1, Charles A. McKenzie1, Ivan Pedroza1, Michelle Swire1, Reed Busse2, Andres Carrillo2, Norman T. Farrar1, Vandana Dialani1, Neil M. Rosky1
1Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; 2GE Medical Systems, Menlo Park, California, USA

This work compares multi-plane Single Shot Fast Spin Echo (SSFSE) imaging to real-time SSFSE (RT-SSFSE) imaging for evaluating fetal abnormalities. Thirty patients referred for fetal MRI were examined with standard SSFSE in the fetal sagittal, coronal, and axial planes. RT-SSFSE was utilized to visualize the pertinent anatomy. For fetuses with ventriculomegaly, question of cleft soft palate, and posterior fossa abnormality, this was the midline sagittal view. Other real-time views were obtained for fetuses with extremity and genitourinary abnormalities. The diagnostic quality of SSFSE and RT-SSFSE images were compared by three radiologists. The RT-SSFSE images were superior in 28/30 cases.

58. T2* Measurements of the Fetal Liver in Response to Maternal Oxygen Breathing
David M. Morris1, Sandra MacVicar2, Thomas W. Redpath1, David R. Abramovich1, Scott I K Semple1, Paul Haggarty1, John A. Ross1, Norman Smith2, Fiona J. Gilbert1
1University of Aberdeen, Aberdeen, UK; 2Aberdeen Maternity Hospital, Aberdeen, UK

MRI offers a safe and non-invasive technique for the investigation of the fetus in-utero. The use of T2* measurements has been suggested as a method for examining fetal blood oxygenation. Maternal oxygen breathing is a method by which the fetal oxygenation can be changed. The T2* of the fetal liver is measured with the mother breathing first air and then oxygen. This allows for any change in T2* to be calculated. The parameter correlated significantly with gestational age at the time of scanning. This represents a step towards determining fetal blood oxygenation.

59. Comparative Study of True Steady-State Free Precession (True SSFP) and Half-Fourier Rare Sequences for Fetal Imaging
Hiroshi Sugimura1, Kenichiro Yamaguchi1, Azusa Shigeno1, Takao Kodama1, Takanori Yano1, Eiji Furukoji1, Shozo Tamura1, Haruyuki Koga1, Yoshih Machida1, Shinichi Kitane1
1University of Miyazaki, Miyazaki, Japan; 2Toshiba Medical Systems Corporation, Otawara, Japan

The true SSFP sequence generates fetal images without motion artifacts. The true SSFP images have similar organ contrast to the half-Fourier RARE except heart and umbilical cord.

60. ASSET Enhanced SSFSE Imaging of the Fetus
Charles Alexander McKenzie1, Deborah Levine1, Martina Morrin1, Norman T. Farrar1, Vandana Dialani1, Neil M. Rosky1
1Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

To examine the feasibility of using ASSET to improve fetal SSFSE imaging, unaccelerated and twofold accelerated SSFSE was performed for 18 patients referred for clinical fetal MRI. Five imaging strategies (one reference plus four ASSET) were tested in each patient. The four ASSET strategies were designed to produce images with the following characteristics, relative to the to the reference: 1) faster acquisition, 2) improved SNR efficiency, 3) thinner slices, and 4) increased in-plane resolution. The resulting images were compared in a random and blinded fashion. The SNR efficient strategy was consistently ranked as having the best overall image quality.

61. 3D MR Microscopy of a Large Human Embryo Collection (Kyoto Collection) to Create a 3D Image Database for Human Embryology
Yoshimasa Matsuda1, Shinya Ono1, Shinya Handa1, Tomoyuki Haishi2, Katsumi Kose1
1University of Tsukuba, Tsukuba, Ibaraki, Japan; 2MR Technology Inc, Tsukuba, Ibaraki, Japan

An efficient (four-channel super-parallel) MR microscope was developed for 3D MR microscopy of 2,000 chemically fixed human embryos. About 500 embryos were already measured at about (100mm)3 isotropic spatial resolution. The 3D image datasets were demonstrated to be useful for studies in human embryology.

62. Analysis of Angiogenesis in Mouse Pregnancy Using BSA-Gd-DTPA Enhanced 3D-MRI
Vicki Plaks1, Eli Geva1, Michal Neeman1, Nava Dekel1
1The Weizmann Institute of Science, Rehovot, Israel

This study aims to characterize angiogenesis at the maternal-fetal interface initiated with implantation to the development of the mature placenta, using macromolecular dynamic contrast enhanced MRI. Analysis of MRI and fluorescence data revealed permeability at implantation sites but not in mature placentas. We speculate that permeability serves to supply the postimplanted embryo with gases and nutrients and enables provisional matrix remodeling and consequent angiogenesis allowing the establishment of mature placental vasculature. MRI follow-up of angiogenic processes associated with implantation and placentation can further be implicated to study associated placental vasculopathy utilizing genetically modified mice showing vascular defects influencing fetal wellbeing.
Tracking Endometrial Cyst Growth Using Magnetic Resonance Imaging

Stephen Lenhard1, Robin Haimbach1, Thomas Schaeffer1, Beat Jucker1, Anthony Sulpizio1, Paul Hieble1, Robert Willette1
1GlaxoSmithKline, King of Prussia, Pennsylvania, USA

Traditional rat models of endometriosis require multiple surgical interventions to monitor the effect of drug treatment on the growth of auto-transplanted uterine tissue. Our laboratory has established a rat model of endometriosis that, through use of serial magnetic resonance imaging, is providing information on the growth and maintenance of auto-transplanted uterine tissue previously not possible using traditional surgical models. Using this model, we can examine pharmacological agents for their effect on the early growth, maintenance and hormone-stimulated re-growth of this tissue.

Ex Vivo and In Vitro Approaches to Physiopathology and Therapeutics

VEGF Overexpression Increases Invasion of a Human Prostate Cancer Cell Line Under Hypoxia in the Presence of Endothelial Cells.

Ellen Ackerstaff1, Fionne B. Wildes1, Venu Raman1, Dmitri Artemov1, Zaver M. Bhujwalla1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Increased expression of vascular endothelial growth factor (VEGF), frequently observed in hypoxic tumors, has been linked to increased metastases. We determined the effects of VEGF overexpression on invasion and metabolism of PC-3 cells in contact with endothelial cells under oxygenation and hypoxia using our Metabolic Boyden Chamber Invasion assay. PC-3 cells overexpressing human full-length VEGF were generated. Under hypoxia, VEGF overexpression increased invasion, decreased levels of intracellular mobile lipids, but did not alter the energy status. The increased invasion detected here may explain, in part, increased rates of metastasis detected in patients with cancers secreting high levels of VEGF.

Anti-inflammatory Agent Indomethacin Reduces Invasion and Causes Metabolic Changes in a Human Breast Cancer Cell Line.

Ellen Ackerstaff1, Barjor Gimi1, Dmitri Artemov1, Zaver M. Bhujwalla1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

The tumor microenvironment is frequently characterized by hypoxia and extracellular acidosis, which can evoke an inflammatory response and influence cell migration, cell invasion, tumor vascularization, and metastasis. Using our MR-compatible Metabolic Boyden Chamber, we investigated the effects of the non-steroidal, anti-inflammatory drug indomethacin on invasion and metabolism of the invasive human breast cancer cell line MDA-MB-435. Indomethacin treatment reduced invasion of MDA-MB-435 cells independent of culture and perfusion conditions, which themselves influenced invasion and metabolism of MDA-MB-435 cells. The profile of choline phospholipid metabolites changed toward a less malignant one with indomethacin treatment.

High-Resolution Magic-Angle Spinning 1H Nuclear Magnetic Resonance Spectroscopy of Human Brain Tumors: Application of Pattern Recognition Method

Wen Xue Chen1, Guang Yao Wu1, Yong Xia Yang1, Hai Yan Lou1, Feng Deng1, Hao Lei1
1The Chinese Academy of Sciences, Wuhan, Hubei, People's Republic of China; 2Huazhong University of Science and Technology, Wuhan, Hubei, People's Republic of China

High-resolution magic angle spinning (HR-MAS) 1H magnetic resonance spectroscopy has been successfully used in studies on biological tissues. In this report, we present a preliminary study of 31 human brain tumors in three categories (glioblastomase, meningioma and hemorrhagic tumors) using this technique and principal components analysis (PCA). The results of our study suggest that HR-MAS 1H NMR combined with PCA can not only reflect certain aspects of tumor biology, but also potentially be used to classify tumor types and tumor grades, and ultimately lead to the development of automatic diagnostic and cure methods.

Characterization of Specific Metabolic Profiles Associated with Malignant Transformation in Cultured Human Astrocytes Using 1H HR-MAS Spectroscopy

Samson Jarso1, John Kurhanewicz2, Andy Zektzer2, Tracy R. McKnight2
1UC Berkeley, Berkeley, California, USA; 2UCSF, San Francisco, California, USA

We studied immortalized normal human astrocytes (NHA), and two strains of genetically engineered human astrocytes that form phenotypically Grade III (GEA3) and Grade IV (GEA4) astrocytoma with high-resolution magic angle spinning (HRMAS) spectroscopy to identify the metabolic characteristics associated with malignant transformation. An unsupervised analysis of all resonance peaks in the HRMAS spectra from the three cell populations showed differences in the concentrations of alanine, glutathione and taurine. As these metabolites are not typically observed in astrocytoma, we interpreted these differences to be more indicative of the genetic features leading to transformation than of the original cell type.
11:48  68. Initial Studies of Ifosfamide and Tumour Metabolism using High-Resolution $^{31}$P MAS
Geoffrey S. Payne1, Yuen-Li Chung2, Sucheta J. Vaidya1, Martin O. Leach2
1Royal Marsden NHS Trust and the Institute of Cancer Research, Sutton, Surrey, UK; 2St George's Hospital Medical School, London, UK

High-resolution $^{31}$P Magic Angle Spinning has been investigated for study of tumour metabolism. Rhabdomyosarcoma xenografts were grown in nude mice. In tumours (n=11) and liver (n=4) samples well-resolved peaks were observed from PE, PC, Pi, GPE and GPC (11.74T; 4 mm rotors, 4°C, 3 kHz spin rate). Pi increased over 2 hours (and pH dropped slightly) but PME and PDE amplitudes did not change significantly. Comparison with tissue extract spectra suggest a sensitivity threshold of ~0.1 mM. Additional peaks at ~18ppm rel PCr appeared if ifosfamide was administered. The method works well and can be applied for biopsy samples.

12:00  69. A New Approach to Sample Class Segregation Based on Application of Bayesian Spectral Decomposition to Metabonomic NMR Data Sets
Radka Stoyanova1, John C. Lindon2, Jeremy K. Nicholson2, Truman R. Brown3
1Fox Chase Cancer Center, Philadelphia, Pennsylvania, USA; 2Imperial College, London, UK; 3Columbia University, New York, USA

We have applied Bayesian Spectral Decomposition to 1H spectra from rat urine following administration of different doses of hydrazine, a known liver toxin. The technique not only separates accurately the treated from control samples, but also provides the spectral shapes and their magnitudes associated with the “normal” and “aberrant” components in the data. The “aberrant” spectral pattern contained peaks of metabolites associated directly with the hydrazine effects, while the “normal” contained intermediates of the Krebs cycle. The magnitudes of the patterns are related to the administered dose of hydrazine and time-related events.

12:12  70. Metabolomic Studies of a Prostate Cancer Cell Line Following RNA Interference-Mediated Silencing of the Fatty Acid Synthase Gene
Yuen-Li Chung2, Johannes V. Swinnen2, Koen Brusselmans2, Marion Stubbs1, John R. Griffiths1
1St George's Hospital Medical School, London, UK; 2Catholic University of Leuven, Leuven, Belgium

FASE, the principal enzyme of fatty acid synthesis, is upregulated in some cancers. We examined the metabolic changes induced by silencing the FASE gene with siRNA. Surprisingly, significant increases in saturated and unsaturated fatty acids were observed. The increased saturated fatty acid may be due to accumulation of malonyl CoA, a FASE substrate, inhibiting oxidation of fatty acids absorbed from the culture medium. Elevated unsaturated fatty acids could be a consequence of apoptosis. Significant decreases in lactate, leucine and isoleucine and elevated high-energy phosphates that were also found could be due to increased oxidation of carbohydrate and amino acids.

Norbert Winfried Lutz2
1University of Arizona, Tucson, Arizona, USA

Cell-cell recognition plays a fundamental role in the invasiveness of cancer, and is linked to oligosaccharides in plasma membrane glycoproteins. This study is aimed at gaining new insight into saccharide metabolism in metastatic tumors, and at exploring the potential of $^{31}$P NMR spectroscopy of UDP-hexoses to detect the metastatic potential of tumors. UDP-hexose levels were determined in extracts of cultured metastatic vs. non-metastatic breast cancer cells. UDP-hexoses were found to vary as a function of metastatic potential and cell density, suggesting that future in-vivo assessment of metastatic potential by $^{31}$P NMR of UDP-hexoses will presumably depend on tumor growth characteristics.

12:36  72. Intracellular-Water Specific MR of Cultured HeLa Cells
Lin Zhao1, Chris Kroenke1, Joseph J.H. Ackerman1, Jeff J. Neil1
1Washington University in St. Louis, St. Louis, Missouri, USA

A method has been developed to specifically select the intracellular water signal from perfused microbead-adherent cells using velocity suppression. This compartment selectivity has been validated through experiments with perfused microbeads only, and through T1 measurements of cells perfused with media at different concentrations of relaxation agent (Gd-DTPA). A lower limit of the intracellular water pre-exchange lifetime was deduced.
A Quantitative Model to Estimate Limited Permeability of Mitochondrial Membrane to Water in Brain

Nanyin Zhang1, Xiao-Hong Zhu1, Wei Chen1
1University of Minnesota Medical School, Minneapolis, Minnesota, USA

It has been observed that the clearance rate of cerebral H$_2^{17}$O in bolus injection experiment is significantly faster than that following $^{17}$O$_2$ inhalation. Slower transport of the H$_2^{17}$O metabolized during the $^{17}$O$_2$ inhalation was expected to result from limited permeability to water across the mitochondria membranes. A model is proposed to quantitatively describe the water transport processes in both experiments. Simulation data were compared to the experimental measurements to validate the model. Permeability of mitochondria membrane to water was also estimated. This study suggests the feasibility of utilizing $^{17}$O NMR to measure the permeability of mitochondria to water in vivo.

GOLD CORPORATE MEMBER LUNCHEON SYMPOSIUM
GE Medical Systems

Main Hall 13:00 – 14:00

SMRT and ISMRM JOINT PRESENTATION
Managing MR Artifacts and Pitfalls
Room A 14:00 – 16:00 Chairs: Kim Butts and John Christopher

Educational Objectives
Upon completion of this session, participants should be able to:
• list many MR artifacts;
• identify and describe the physical causes of many common MR artifacts;
• describe how these artifacts hinder clinical interpretation of MR images;
• identify imaging tasks that are made difficult by the presence of artifacts;
• describe imaging solutions to prevent artifacts in MR images.

14:00 MRI Artifacts: A Technical Perspective
Gregory C. Brown

14:25 The Physics of Cardiac and Blood Flow Artifacts
David N. Firmin

14:50 Neuro and Vascular Pitfalls
William G. Bradley

15:15 Body and Cardiac Pitfalls
Katsuyoshi Ito

15:40 Discussion

16:00 Adjournment
## CLINICAL SCIENCE FOCUS SESSION

### Clinical Applications of 3T and Beyond

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<th>Time</th>
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| 14:00 | **Ultra Fast T₂-Weighted TSE Sequences with Flip Angle Sweep and SENSE at 3T**  
Jürgen Gieseke¹, Christiane Kuhl¹, Marcus von Falkenhausen¹, Renate Blömer¹, Okan Gür¹,  
Gerd van Yperen², Hans Schild³, Götz Lutterbey¹  
¹University of Bonn, Bonn, Germany; ²Philips Medical Systems, Best, Netherlands  
Turbo Spin-echo (TSE)-sequences appear to be very attractive for high field applications. However their application at 3T interfere with high RF power deposition. In this paper, a new method is presented, which is designed to provide T2-weighted images in 8.4s. 50 patients were examined with this new method at 3T. We have presented and successfully implemented a new Method, FAS combined with SENSE, which enables T2-weighted imaging with high spatial resolution and diagnostic quality. This reduced the scan time about a factor 12. FAS with SENSE is a very useful technique in the clinical routine. |
| 14:10 | **Fast FLAIR Imaging of the Normal Brain: Comparison of 3.0T Vs 1.5T**  
Chul-Ho Sohn¹, Xingchang Wei², Richard Frayne², Kyung Hwan Byun¹, Mark Bristow²,  
Micheal Laczon Lanzon³, Robert Junior Sevick²  
¹Keimyung University, DongSan Medical Center, Daegu, Republic of Korea; ²University of Calgary, Calgary, Alberta, Canada; ³Pochon CHA University, Kumi CHA Hospital, Kumi, KyungBuk, Republic of Korea  
In recent years, 3.0 T MR scanners have been used for neurological imaging. We have found that there are several differences in the MR findings in normal brain when using FLAIR at 3.0 T compared to 1.5 T. Theses observations suggest differences in the signal intensities of the CS, pulvinar thalami (PT), and normal iron-containing structures (ICS) [such as globus pallidus (GP), dentate nucleus of cerebellum (DN), red nucleus (RN), pars reticulata of substantia nigra (SN), and putamen (P)]. Our objective was to evaluate these differences in FLAIR imaging between 3.0 T and 1.5 T in normal human brains. |
| 14:20 | **Neuroradiological Applications of Hyperecho-TSE Sequences at 3T: First Clinical Results**  
Matthias Weigel¹, Sargon Ziyeh¹, Irina Mader¹, Johannes Weber¹, Juergen Hennig¹  
¹University Hospital Freiburg, Freiburg, Germany  
Recently, the novel rf pulse mechanisms hyperecho-es and TRAPS were proposed to subdue SAR problems of turbo spin echo sequences (TSE) especially at high fields. Though these hyperTSE sequences proved to achieve similar contrast and SNR in normal controls compared to conventional TSE180, their sensitivity to display pathologies still has to be evaluated in clinical studies. This preliminary study demonstrates that hyperTSE sequences show both, an equivalent capability of resolving different types of pathologies and an excellent contrast between cerebral WM and GM while saving as much as 67% in SAR. |
| 14:30 | **High Resolution 3T GR-EPI in the Caudal Brain**  
Simon Robinson¹, Christian Windischberger¹, Alexander Rauscher¹, Ewald Moser³  
¹Vienna University, Vienna, Austria; ³University and General Hospital, Vienna, Austria  
Gradient-recalled EPI was optimised for the amygdalae and 3T in terms of imaging orientation, in-plane resolution, slice thickness and effective echo time, via field maps and SNR in the amygdalae. An oblique axial geometry with a matrix size of 128x128 and 2mm thick slices was found to be optimum. T₂* in the amygdala increased from 22ms with standard EPI to 48ms with these parameters, showing effective reduction of intravoxel dephasing. An increase in time-series SNR of 60% in the amygdala over standard resolution EPI offers this as a promising basis for sound MRI studies of the amygdalae. |
| 14:40 | **High Resolution MRI Neuromorphometric Assessment of the Hippocampal Subiculum in Mood Disorders**  
Allison Carol Nugent¹, Suzanne Wood¹, Earle Bain¹, Linda Mah⁴, Sean Marrett¹, Alan Koretsky⁵,  
Lalith Talagala¹, Joel Price², Dennis Charney³, Wayne Curtis Drevets¹  
¹National Institute of Mental Health, Bethesda, Maryland, USA; ²National Institutes of Health, Bethesda, Maryland, USA; ³Washington University, St. Louis, Missouri, USA  
Neuromorphometric MRI studies report reductions in hippocampal volume in mood disorders, although differences relative to control samples have been subtle, and were not confirmed by most replication attempts. Post mortem studies, however, have revealed reductions in volume of the hippocampal subiculum. The current study investigated whether the subiculum can be reliably segmented in high resolution MRI images, and compared mean subiculum volumes between bipolar and control samples. |
High resolution images at 4.7 Tesla of the hippocampus were obtained using a birdcage coil and a Fast Spin Echo (FSE) sequence with in-plane resolution of 0.5 mm, and slice thicknesses of 1 and 2 mm. The structure observed within the hippocampus was compared. A novel noise filter was used on the 1 mm slices to improve the signal-to-noise ratio. This method will be good for monitoring neuronal loss in the hippocampus due to neurodegenerative disorders and the effects of mesial temporal sclerosis.

According to our preliminary results high-field (3.0T) MRI was found superior to standard MRI for diagnosis and surgery of sellar lesions. Due to its higher resolution, 3.0T MRI was able to visualize microadenomas that were only suspected on standard MRI, to delineate parasellar anatomy to a detail that the medial cavernous sinus border was visible, which led to a positive correlation to surgical findings in 84% of 3.0T MRI compared to 59% of standard MRI in predicting tumor invasion of the cavernous sinus, and to provide optimal imaging during intraoperative navigation.

Lowering of $T_2$ relaxation times as seen on 3T MRI has been associated previously with brain iron while prolongation of $T_2$ has been shown to correlate with increased water content. This study describes novel features that relate to increase in proportion of voxels with low or high $T_2$. It demonstrates the use of these quantitative distributional parameters in classification of Alzheimer’s disease. Clustering of features and visualization of the clusters show that most significant features that discriminate between cognitively healthy controls and Alzheimer’s fall into categories of lower tail, spread, and upper tail features of the $T_2$ distributions.

Our aim was to investigate whether it was possible to perform high b value DTI in the neonatal brain at 3T, and to determine whether ADC, FA or image contrast change with increasing b value. DTI was obtained on a Philips 3T Intera system with b values of 350, 700, 1500 and 3000 s/mm². FA was not altered, but ADC values decreased with increasing b value. In the thalamus, this decrease appeared to be non-linear. Isotropic diffusion image contrast increases at high b value, which may have an important clinical utility in identifying lesions in the neonatal brain.

A paradigm is proposed for fMRI studies of complex associative cognitive brain activation, which could be used for less cooperative patients. Subliminally primed, response to target task with changing prime-target intervals was studied by response time measurement concomitant with fMRI evaluation of brain activation. The conventional, long, event-related design is often unacceptable for certain patient populations. Two paradigms were compared: continuous ramped increment of prime-target delays and block design of alternating blocks with short and long prime-target intervals. The ramp design exposed subcortical activation not revealed by the block design, within an acceptable increase in study duration.
15:40  **84. Can Two Wrongs Make A Right? B₁-insensitive T₁-weighted Imaging of the Human Brain at 4.7T using 3D MDEFT with a Standard Non-Adiabatic Preparation Pulse**

David L. Thomas¹, Enrico De Vita¹, Ralf Deichmann¹, Robert Turner¹, Roger J. Ordidge¹

¹University College London, London, UK

A modified version of 3D FLASH MDEFT is proposed to overcome the problem of B₁ inhomogeneity in structural imaging of the human brain at 4.7T. In this sequence, the adiabatic inversion spin preparation pulse is replaced by a standard hard nominal 130º pulse. The robustness of the sequence to B₁ inhomogeneity is substantially increased, due the compensating effects of the preparation and excitation pulses, while maintaining good image contrast. The resulting images have improved uniformity compared to the standard MDEFT sequence, both in signal intensity and contrast between grey and white matter.

15:50  **85. Stroke Imaging at 8 Tesla MRI**

Vera Novak¹, Amir M. Abduljalil², Peter Novak³, Donald Chakeres²

¹Harvard Medical School, Boston, Massachusetts, USA; ²Ohio State University, Columbus, Ohio, USA; ³Boston University, Boston, Massachusetts, USA

High field MRI at 8T offers increased resolution for visualization of infarct site and stroke diagnosis. Fourteen patients with the first ischemic stroke or transient ischemic attack (TIA) were studied using 8T and 1.5T MRI. Gradient echo images (GE) at 8T revealed infarct as a high signal area, often surrounded by a low signal area suggestive of iron deposits. In addition, infarct was found in 2 TIA patients with normal 1.5T MRI. Additional white matter lesions and incidental angiomas were observed. High resolution MRI at 8T may increase sensitivity for infarct visualization and reveal features underlying pathophysiology of stroke.

**BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)**

**MR Spectroscopy Applications: In Vivo Dynamic Metabolism and Metabolomics**

Room B-1  14:00 – 16:00  Chairs: Jerry D. Glickson and Douglas L. Rothman

Please see page   for details.

**BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)**

**MR Spectroscopy Applications: In Vivo Dynamic Metabolism and Metabolomics**

Room B-2  14:00 – 16:00  Chairs: Jeffrey L. Evelhoch and Charles S. Springer

Please see page   for details.

**Diffusion: Models and Errors**

Main Hall  16:30 - 18:30  Chairs: Peter J. Basser and Geoffrey J.M. Parker

16:30  **86. Young Investigator Awards Finalist: "Squashing Peanuts and Smashing Pumpkins": How Noise Distorts Diffusion-Weighted MR Data**

Derek K. Jones¹, Peter J. Basser⁴

¹National Institutes of Health, Bethesda, Maryland, USA

High diffusion-weighting (DW) or high voxel-resolution DWI applications can result in a sufficiently low SNR that some DW-signals approach the rectified noise-floor. This results in several pernicious artifacts including an orientationally-dependent deviation from a Gaussian distribution of the ADC, underestimated diffusion anisotropy, a negative correlation between mean diffusivity and diffusion anisotropy estimates, increased gray/white matter contrast at high b-values, and elevated anisotropy in acute ischemia. We show that these artifacts, (which are not present below $b \sim 1300 \text{s/mm}^2$ in typical DT-MRI brain studies), can be understood using the peanut-shaped angular ADC profile. Finally, we propose a remedy for these artifacts.

16:50  **87. Effects of Susceptibility Distortions on Tractography**

Jesper L.R. Andersson¹, Marlene Richter², Wolfgang Richter², Stefan Skare³, Rita G. Nunes³, Matthew D. Robson³, Timothy EJ Behrens³

¹Karolinska Institute, Stockholm, Sweden; ²Princeton University, Princeton, New Jersey, USA; ³University of Oxford, Oxford, UK

Susceptibility induced distortions in DTI will leave the principal direction of the tensor approximately unchanged, while distorting anatomy. This means that the principal eigenvectors will point to the wrong anatomical location, adversely affecting tractography. We tested this hypothesis by performing tract tracing before and after correction for distortions. The results show clear differences, and we believe that the tracts reconstructed from the corrected data better reflect anatomy.
17:02  88. Direct Estimation of Fibre Orientations in Partial Volume Contaminated Regions using Spherical Deconvolution
Jacques-Donald Tournier¹, Fernando Calamante¹, David G. Gadian¹, Alan Connelly¹
¹University College London, London, UK

Estimations of fibre orientation using the diffusion tensor model have been shown to be inadequate in partial volume contaminated regions. We propose a novel technique for estimating the distribution of fibre orientations, by deconvolving the signal profile for a single fibre population from the signal profile actually measured with a high angular resolution diffusion-weighted acquisition. Simulations shown for the case of two crossing fibres demonstrate that the method can adequately reconstruct the distribution of fibre orientations. However, this technique has the advantage that the number of fibre populations in each voxel does not need to be known a priori.

17:14  89. Multiple Fiber Orientations Resolved by Generalized Diffusion Tensor Imaging
Evren Ozarslan¹, Baba C. Vemuri¹, Thomas H. Mareci¹
¹University of Florida, Gainesville, Florida, USA

The feasibility of using the recently proposed generalized diffusion tensor imaging (DTI) method to resolve different fiber orientations is discussed. Traditional (rank-2) DTI, HARDI, q-space imaging and generalized DTI (employing a rank-8 diffusion tensor) techniques are simulated in simple one, two and three fiber systems. It was found that when monoexponential diffusion model is assumed along each direction, the resultant water displacement profile can identify multiple orientations within the voxel, without the need to acquire images at high b-values.

17:26  90. A Comparison of q-Ball and PASMRI on Sparse Diffusion MRI Data
Daniel Alexander¹
¹University College London, London, UK

This study compares two algorithms, PASMRI and q-ball imaging, for resolving the orientations of crossing fibres using diffusion MR data. We compare the performance quantitatively on synthetic data in which the number and direction of the crossing fibres is known and qualitatively on human brain data. We find that PASMRI resolves fibre orientations more consistently, but that a small increase in data quality call allow q-ball, which is much faster than PASMRI, to produce similar results.

17:38  91. Q-Ball Imaging of Gyral White Matter Architecture in Macaque Cortex
David S. Tuch¹, Mark H. Khachaturian¹, Wim Vanduffel¹
¹Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA

High angular resolution diffusion imaging (HARDI) provides a powerful tool for mapping subvoxel neural histoarchitecture. However, HARDI studies to date have focused primarily on deep white matter pathways. Here, using q-ball imaging in macaque cortex, we show that gyral white matter exhibits significant intravoxel fiber crossing architecture. The crossing structure may be due to the dispersion of fibers at the gyral crown, or to the rapid bending of the white matter insertions into gray matter. The ability to map gyral white matter histoarchitecture with diffusion imaging will ultimately enable the tractography program to examine detailed connectivity within individual gyri.

17:50  92. Generalized Diffusion Tensor Imaging of Excised Rat Brain
Evren Ozarslan¹, Baba C. Vemuri¹, Thomas H. Mareci¹
¹University of Florida, Gainesville, Florida, USA

Generalized diffusion tensor imaging (DTI) method employs Cartesian tensors of higher ranks to overcome some of the difficulties experienced with traditional diffusion tensor imaging. This study uses this methodology on an excised rat brain to construct displacement probabilities and fiber orientations. The results indicate that generalized DTI is capable of resolving complicated structures in the rat brain.

18:02  93. Assessment of Axonal Fiber Tract Architecture in Rat Spinal Cord by Localized NMR q-Space Imaging: Simulations and Experimental Studies
Chih-Liang Chin¹, Felix W. Wehrli¹, Yingli Fan¹, Scott N. Hwang³, Eric D. Schwartz¹, Jonathan Nissanov², David B. Hackney¹
¹University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA; ²Drexel University College of Medicine, Philadelphia, Pennsylvania, USA; ³New York University Medical Center, New York, USA; ¹Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

NMR q-space imaging has been applied to the study of biological structures. However, the complexity of tissue architecture poses challenges to the interpretation of q-space data. Here, the q-space echo attenuation was simulated based on histologic images of structurally different rat spinal cord fiber tracts and the data obtained with structural parameters computed from the histologic images. Mean displacements and kurtosis were found to parallel mean axon size and axonal density. The data are also compatible with spatially localized q-space measurements conducted at the same locations suggesting this approach to have potential for nondestructive analysis of the axonal architecture.
The Problem with Peanuts
Peter J. Basser, Sinisa Pajevic
1National Institutes of Health, Bethesda, Maryland, USA

Defining the apparent diffusion coefficient (ADC) as the ratio of the apparent mean-squared displacement and twice the diffusion time appears to be a valid application of the Einstein equation, however, it leads to a discrepancy between the molecular scale diffusivity and the ADC in both hindered and restricted geometries. Moreover, directionally dependent ADC measurements will generally not reflect the true microscopic diffusion profile, obscuring the underlying microstructure. This problem arises because the mean-squared displacement measured by MR detects the component of all molecular displacements along a particular direction rather than diffusive motion purely along that direction.

MR PHYSICS AND TECHNIQUES FOR CLINICIANS

Educational Objectives
Upon completion of this course, participants should be able to:

• Define and describe the fundamental principles of MR imaging, including the definition of spin magnetization, the Larmor relationship, relaxation phenomena, and the process of using the spin magnetization to produce an image;
• Explain imaging pulse sequences based upon spin and gradient echoes, including fast spin echo and echo planar techniques;
• Design MR imaging protocols for diagnostic applications considering image contrast, spatial resolution, acquisition time, signal-to-noise ratio, and artifacts;
• Describe the principles and capabilities of various advanced MR techniques, including diffusion, cardiac and functional MRI and spectroscopy.

Spin Gymnastics I
Walter Kucharczyk and Donald B. Plewes

Spin Gymnastics II
Walter Kucharczyk and Donald B. Plewes

Hardware
Richard G.S. Spencer

Adjournment

Artifacts and Correction

Rapid Real-Time Prospective Rigid Body Motion Correction During Imaging Using Clover-Leaf Navigators
André JW van der Kouwe, Anders M. Dale
1Massachusetts General Hospital, Charlestown, Massachusetts, USA

Subject motion frequently corrupts MR images of the head, especially in uncooperative subjects and long three dimensional scans. We present a prospective real-time motion correction technique that uses embedded clover-leaf navigators to rapidly track head rotations and translations. The relationship between the navigator signal and rotations is established in a preliminary mapping step. Translations are calculated from the straight-line sections of the navigator. Results from our FLASH implementation illustrate that the system tracks large head rotations and produces a significantly improved image after phase errors due to translation are also corrected.

CARE: Coil-based Artifact Reduction
David Atkinson, David J. Larkman, Philipp G. Batchelor, Derek L.G. Hill, Joseph V. Hajnal
1Guy's Hospital, King's College London, London, UK; 2Hammersmith Hospital, Imperial College London, London, UK

Multiple receive coils with differing spatial sensitivities provide complementary information about an object. We use this data to correct image artifacts that arise from object changes such as motion or flowing blood. The artifact cause is expressed as an equivalent change to the coil sensitivities, for example the shift of a head within a stationary head coil is represented instead as a movement of the coil. The object is reconstructed from different combinations of coils and an optimisation routine used to find the corrections to the coil profiles that make these reconstructions consistent. Clear improvements in image quality are observed.
Prospective Correction of Affine Respiratory Motion for Non-Cartesian Coronary MRI
Kay Nehrke¹, Peter Börnert¹
¹Philips Research Laboratories, Hamburg, Germany

A new technique providing prospective correction of affine respiratory motion based on patient-specific motion models has been implemented for cartesian, spiral and radial imaging sequences on a clinical scanner. The basic technical performance has been tested in experiments on moving phantoms. In addition, experiments on healthy volunteers have been carried out to show the potential for coronary MRA. The results indicate that patient-specific prospective correction of affine motion may be used to increase gating efficiency without degrading image quality.

Correction of Motion Artifacts in Time-Resolved Contrast Enhanced MRA Using Convex Projections
Ashish - Raj², Ramin Zabih², Martin Prince², Honglei Zhang²
²Cornell University, Ithaca, New York, USA; ³Cornell-Well Medical College, New York, USA

An iterative convex projection method is presented to remove motion artifacts in time-resolved MRA. We place constraints on the temporal changes allowed to occur between one frame in the sequence to the next. We put these constraints within a convex projections framework. These constraints are defined in both k-space and image space, and thus are highly independent. Convergence is fast. Preliminary results suggest significant gains in image quality.

Reduction of Blurring in View Angle Tilting MRI with Multiple VAT Readouts
Kim Butts¹, Laura Pisani¹
¹Stanford University, Stanford, California, USA

Blurring is reduced in view angle tilting MRI by matching the readout duration to that of the main lobe of the RF pulse. In this work, we demonstrate a method to do this, while efficiently using the transverse magnetization, with the use of multiple high bandwidth VAT readouts. Multiple VAT readouts are shown to be effective with either a flyback or echo planar trajectories, as long as the VAT gradient is fully refocused each readout. Images are demonstrated without in-plane distortions from off-resonant spins, and with much improved SNR over a single high BW readout.

K-Space Analysis and Correction of a Coherence-induced Artifact in 3D Fast-Large-Angle Spin Echo (FLASE)
Branimir Vasilic¹, Hee Kwon Song¹, Felix W. Wehrli¹
¹University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA

High-resolution imaging of trabecular bone is preferably performed with spin-echo-type sequences. These are immune to artificial broadening of trabeculae caused by local gradients near the bone-bone marrow interface and signal loss from chemical shift dephasing. Due to refocusing pulse imperfections these sequences can be prone to a banding artifact in both the readout and slice direction. The imperfect refocusing pulse partially stores the phase-encoded transverse magnetization as longitudinal magnetization that recurs as transverse magnetization in the subsequent repetition, forming a spurious echo. Here we provide k-space analysis of the artifact and propose a remedy.

Compensation for Maxwell Cross-Terms in Diffusion-Weighted Imaging
Michael S. Zwanger¹, David Porter¹, Thorsten Feiweier¹, Peter Heubel¹, Timothy G. Reese², Thomas Benner², John E. Kirsch³
¹Siemens Medical Solutions, Erlangen, Germany; ²Athinoula A. Martinos Center, Charlestown, Massachusetts, USA; ³Siemens Medical Solutions, Malvern, Pennsylvania, USA

Using an asymmetric gradient coil and a DWI sequence with dual bipolar diffusion gradients, first order Maxwell cross-terms can cause artifacts in diffusion-weighted images due to a substantial shift in k-space. The observed effects are consistent with theoretical predictions derived from Maxwell’s equations and can be compensated for by using the theoretical expressions to modify the applied gradients. A modified DWI EPI sequence was used on a 3T Magnetom Allegra Scanner to demonstrate the effectiveness of this compensation.

Sensitivity to RF and B₀ Field Imperfections in Continuous Moving-Table MR Imaging
Bernd Aldefeld¹, Peter Börnert¹, Jochen Keupp¹
¹Philips Research Laboratories, Hamburg, Germany

Continuous moving-table MRI poses new problems with respect to image quality because imperfections of the magnetic fields cause additional, motion-dependent phase errors, which are unknown in conventional MRI. The source of these errors is examined, and experiments demonstrate their effects on the image quality for different k-space acquisition orders. It is shown that even moderate phase errors induce serious image artefacts in segmented k-space gradient-echo acquisitions.
Continuous Adjustment of Calibration Values for Improved Image Quality in Continuously Moving Table Imaging

Ajit Shankaranarayanan1, Jean Brittain1
1GE Medical Systems, Menlo Park, California, USA

A method is described for adjusting the calibration values in real time for whole-body axial imaging using a continuously moving table acquisition. Images acquired with real time adjustments of the various calibration parameters are compared to those acquired with fixed parameters.

Generic Eddy-Current Compensation in Balanced Steady-State Free Precession

Oliver Bieri1, Klaus Scheffler1
1University of Basel, Basel, Switzerland

Balanced steady-state free precession (b-SSFP) imaging is very sensitive to any imperfections perturbing the nulled zeroth order moment of the applied gradient scheme. A possible source are eddy-currents that change during the excitation train produced by the changing phase encoding (PE) gradients. Rapid and large changes of the k-space trajectory generate significant spin-dephasing, thus signal instabilities and fluctuations leading to image artifacts. Generic eddy-current compensation strategies are proposed which allow complete freedom of 2D & 3D k-space trajectories.

Human Brain MR Spectroscopy: 3T and Beyond

Reproducibility of 1H Spectroscopic Imaging of the Human Hippocampus

Wen-Jang Chu1, Cynthia Pan1, Jullie W. Pan1, Hoby P. Hetherington1
1Albert Einstein College of Medicine, Bronx, New York, USA

Despite the non-invasive nature of 1H spectroscopic imaging, few longitudinal SI studies of the hippocampus have been reported. To enable longitudinal studies of the human hippocampus we have developed an automated co-registration, selection and reconstruction method that maximizes anatomical coherence between different SI studies. Compared to conventional voxel selection routines, these methods reduce the scan-to-scan variability of hippocampal Cr/NAA measurements by 47%. The scan-to-scan SD is ~20% of mean difference between controls and patients with temporal lobe epilepsy or Alzheimers. This approach should allow longitudinal studies in these patient groups, comparing changes at the level of single voxels (0.64cc).

Eicosapentanoic Acid Supplementation Alters 1H MRS Metabolite Profiles in First Episode Psychosis

R Mark Wellard1, Stephen J. Wood2, Mirabel McConchie2, Graeme David Jackson1, Dennis Velakoulis2, Patrick Denistoun McGorry2, Christos Pantelis2, Gregor E. Berger2
1Brain Research Institute, Heidelberg West, Victoria, Australia; 2University of Melbourne, Melbourne, Victoria, Australia

Bioactive lipids have been implicated in the etiology of psychosis. This study investigated the effect of eicosapentanoic acid (EPA) supplementation (for 12 weeks) on the metabolite profile first episode psychosis. After an initial 1H-MRS examination, patients had either EPA (n=12) or placebo (n=12) to supplement standard treatment for 12 weeks, prior to a second MRS study. ANCOVA showed significant changes over time (p<0.05) for TMA and Cr. EPA treatment affected Cr, and there was an interaction between treatment and time for myo-inositol and GSH. These results suggest that EPA supplementation assists with normalizing metabolite changes in early psychosis.

Subclinical Hepatic Encephalopathy in Children Studied by In Vivo 1H NMR Spectroscopy at 4 Tesla

Ivan Tkac1, Heather R. Hamernick1, Sally Weisdorf-Schindler1, Gulin Oc1, Pierre-Gilles Henry1, Rolf Gruetter1
1University of Minnesota, Minneapolis, Minnesota, USA

Pre-transplant pediatric candidates with hepatic encephalopathy (HE) were examined using neurological and neuropsychological testing, blood analysis, and in vivo 1H NMR spectroscopy at 4T. Ten metabolites were quantified with Cramer-Rao lower bounds below 20%, including glutamine and myo-inositol, known markers of chronic HE. Reliable discrimination of Glu and Gln improved sensitivity of the method to detect small pathological changes in the brain in individual patients compared to controls. The precision of individual Gln measurements (CRLB<10%) was well below the scatter of Gln concentrations in patients (4 - 9mM), indicating the potential to grade subclinical HE using 1H NMR spectroscopy.

Functional Spectroscopy of Pain at 4T

Paul Gerald1, Mark Mullins1, Laura Rowland1, Rex E. Jung1, Willmer Sibbit1
1University of New Mexico, Albuquerque, New Mexico, USA

Brain activity measured with fMRI reflects hemodynamic changes associated with increase in energy demand due to neuronal activity, glutamate neurotransmission, and glutamate – glutamine cycling. We postulate that a stimulus that produces a hemodynamic response should also produce an elevation in glutamate and glutamate concentrations, which should be detectable with proton spectroscopy at 4T. We present results showing that a painful stimulus does indeed cause an increase in glutamate (9.9%) and glutamine (20.3%) concentrations in a region involved in the processing of painful stimuli, the Anterior Cingulate gyrus, demonstrating a new non –invasive tool for the study of brain function.
17:18 109. In Vivo Detection of Gray and White Matter Differences in GABA Concentration in the Human Brain using Chemical Shift Imaging of GABA

In-Young Choi¹, Sang-Pil Lee¹, Hellmut Merkle², Jun Shen²
¹The Nathan Kline Institute, Orangeburg, New York, USA; ²National Institutes of Health, Bethesda, Maryland, USA

Chemical shift imaging (CSI) of GABA is fraught with daunting technical challenges. In this paper, we report CSI of multiple quantum filtered GABA doublet at 3.0 ppm with complete suppression of overlapping creatine and glutathione throughout the entire GABA CSI slice. Based on the field map obtained and our single-voxel studies using the same pulse sequence, macromolecule contamination should be negligible. Using this method, we also present, to the best of our knowledge, the first report of noninvasive in vivo detection of GABA concentration distribution between gray and white matters in the living brain.

17:30 110. Proton MR Spectroscopy of Substantia Nigra in the Human Brain at 4 Tesla: Measurement of High GABA Concentrations

Gulin Oz¹, Paul J. Tuie¹, Melissa Terpstra¹, Ivan Tkac¹, Pratibha Aia¹, Jodi Lowary¹, Rolf Gruetter¹
¹University of Minnesota, Minneapolis, Minnesota, USA

Substantia nigra (SN) is the primary affected brain region in Parkinson’s disease (PD). Single voxel ¹H MR spectra were acquired at 4 Tesla from small volumes (2.2-3.4ml) encompassing the SN of healthy volunteers (n=8) and mild-moderate PD patients (n=9). A series of metabolites including GABA, glutamate and glutathione were quantified using LCModel with reasonable reliability in individuals. Glutamate concentrations of half the cortical values and GABA levels 3-4 fold higher than cortex were measured in very good agreement with neurochemistry literature.

17:42 111. Brain GABA Levels in Cocaine Dependent Subjects Increased After the Treatment for Cocaine Dependence

Yong Ke¹, Chris Streeter², Leanne Nassar³, Ofra Sarid-Segal³, John Hennon³, Deborah Yurgelun-Todd³, Melanie Rendall³, Staci Gruber³, Steve Blank³, Ariel Nason³, Melissa Mudrick³, Clifford Knapp³, Domenic Ciraulo³, Perry Renshaw³
¹Harvard Medical School, Belmont, Massachusetts, USA; ²Boston University School of Medicine, Boston, Massachusetts, USA; ³University of Western Ontario, London, Ontario, Canada

Abnormal brain GABA levels in cocaine dependent (CD) subjects may affect response to drug abuse treatment. Decreased brain GABA levels were reported in ethanol and cocaine dependent persons using MRS editing techniques. Using a quantitative method based on J-resolved 2D MRS technique, frontal lobe GABA levels in 35 cocaine dependent subjects and 20 controls were measured. For patients, the MRS data were acquired before and after an eight-week treatment for cocaine dependence. Our results revealed some significant differences in GABA levels between patients and controls, as well as the GABA levels before and after the treatment in CD subjects.

17:54 112. A 4.0 T ³¹P Magnetic Resonance Spectroscopy Study of Chronic and First-Episode Schizophrenia

Jodi E. Miller², J E. Jensen³, P C. Williamson³, R Manchanda³, R S. Menon³, J Neufeld³, D J. Drost¹
¹Lawson Health Research Institute, London, Ontario, Canada; ²McLean Hospital, Belmont, Massachusetts, USA; ³University of Western Ontario, London, Ontario, Canada

In first-episode and chronic schizophrenia, membrane metabolism may be altered in regions associated with hallucinations, attention and sensory processing. In-vivo 31P MRS, 3D-CSI spectra (15cc voxels) were acquired from 13 first-episode schizophrenics and 13 matched controls plus 8 chronic schizophrenics and 8 matched controls. In the left superior temporal lobe (LST), decreased phosphocholine (p=0.004) was observed in first-episode schizophrenics relative to controls. In the right inferior parietal lobe (RIP), decreased glycerolphosphoethanolamine (p=0.009) was observed in chronic schizophrenics relative to controls. These abnormalities are linked to hallucinations (LST) and the attentional system (RIP), problem areas associated with the symptoms of schizophrenia.

18:06 113. Improvement of the Spectral Resolution for Glutamate and Glutamine in the Human Brain at 4.7 T by using a Localized 2D Constant Time COSY

Hidehiro Watanabe¹, Nobuhiro Takaya¹, Fumiyuki Mitumori¹
¹National Institutes for Environmental Studies, Tsukuba, Ibaraki, Japan

Improvement of the spectral resolution for glutamate and glutamine in the human brain is demonstrated at 4.7 T by using a localized 2D constant time (CT) COSY. In phantom experiments, those peaks were overlapped in a conventional 1D spectrum and on a 2D COSY spectrum. By using 2D CT COSY, these peaks were clearly resolved on a 2D plane by virtue of decoupled Jcoupled. These peaks were also resolved on a localized 2D CT COSY spectrum obtained from a parieto-occipital region (27 ml) in a human brain. The cross peaks between GABA-3 and GABA-4 could be also detected.
18:18 114. **Differentiating High-Energy Phosphate Metabolites and pH in Human Gray and White Matters by using 3D $^{31}$P Chemical Shift Imaging of Entire Brain at 7 Tesla**  
Xiao-Hong Zhu¹, Hongyan Qiao¹, Xiaoliang Zhang¹, Wei Chen¹  
¹University of Minnesota, Minneapolis, Minnesota, USA

*In vivo* $^{31}$P chemical shift imaging (CSI) was performed on entire human brain at 7 Tesla. The grouped spectra from different brain tissue compartments were analyzed for the quantification of ATP, PCr and other phosphate metabolites, pH and magnesium. Excellent $^{31}$P NMR sensitivity and improved spectral resolution achieved at 7 Tesla are capable of determining small differences of the measurable parameters (in the $^{31}$P CSI data) between the gray matter and white matter reliably. This study suggests that ultra-high field strength is significantly advantageous for performing *in vivo* $^{31}$P spectroscopy on human brain for better understanding of functional bioenergetics.

**fMRI of Primary Sensory Activation**

Annex 2 16:30 - 18:30  
**Chairs: Ikuhiro Kida and Richard B. Buxton**

16:30 115. **Retinotopic Mapping in Human Visual Cortex using Vascular-Space-Occupancy (VASO) Dependent fMRI**  
Hanzhang Lu¹, Gianpaolo Basso¹, John T. Serences¹, Steven Yantis¹, Xavier Golay¹, Peter C. van Zijl¹  
¹Johns Hopkins University, Baltimore, Maryland, USA

Recently we introduced a new fMRI methodology based on changes in blood volume. Such a VASO dependent fMRI has been tested using simple checkerboard visual stimulation, breathholding and hyperventilation. To study whether this technique can be used for advanced brain mapping applications, we performed retinotopic mapping using alternating horizontal and vertical wedges that stimulate different portions of the visual field. The results using VASO fMRI showed clear boundaries for ventral and dorsal V1/V2, V2/V3 and V2/VP, similar to the maps obtained using BOLD. VASO fMRI may be a useful alternative method for verification of BOLD data and/or obtaining complementary information.

16:42 116. **Attention Modulation of S1 Activation in Blind and Sighted Subjects: A Pilot Study**  
Annette Sterr¹, Arshad Zaman², Chantal Hayward², Bill Bimson², Neil Roberts²  
¹University of Surrey, Surrey, UK; ²University of Liverpool, Liverpool, UK

The experiment was designed to assess the modulation of SI activation in blind and sighted subjects. Activation extend was compared for an oddball paradigm under attended and ignored conditions. In both groups attention massively increased the activated volume. While no group differences were found for the attend condition, analysis revealed a ~20 time greater SI activation in the blind when stimuli were ignored. This finding supports the idea that higher cognitive functions such as top-down mechanisms may also be subject to adaptational processes.

16:54 117. **Closing the Eyes in Blind-Folded Subjects Induces Deactivation in Early Visual Cortex**  
Kamil Uludag¹, David J. Dubowitz¹, Richard B. Buxton¹  
¹UCSD, La Jolla, California, USA

In a previous study, we have investigated responses to visual stimulus after closing and opening the eyes as resting conditions. We have found with fMRI that closing the eyes lowers the cerebral blood flow significantly compared to 'eyes open'. However, it was not clear if this effect can be referred to lowering the photic stimulation due closing the eyes. Here, we blind-folded the subjects and alternated every 40 seconds between 'eyes open' and 'eyes closed'. Interestingly, a large deactivation in the early visual cortex was caused by simply closing the eyes with no change in photic stimulation.

17:06 118. **Neuronal Inhibition Induces Downregulation of Flow and Metabolism**  
Bojana Stefanovic¹, Jan M. Warnking¹, G. Bruce Pike¹  
¹Montreal Neurological Institute, Montreal, Quebec, Canada

Ipsilateral neuronal inhibition was produced through a periodic, low-force right-hand pinch grip task and the accompanying changes in BOLD signal, blood flow and oxygen consumption measured. In all 8 subjects, BOLD, CBF and CMRO2 increased in the contra- and decreased in the ipsilateral primary motor cortex. The relative changes in CMRO2 and CBF were linearly related, with a slope of ~0.4, in close agreement with the earlier studies of M1 CBF and CMRO2 increases. This hemodynamic and metabolic downregulation accompanying neuronal inhibition establishes the sustained negative BOLD response as a marker of neuronal deactivation.
17:18 119. Functional MRI of Somatosensory Gating

Fred Tam¹, Jonathan Marmurek², S. Nicole Baker¹, W. Richard Staines³, William E. McIlroy⁴, Sandra E. Black⁵, Simon J. Graham⁶
¹Sunnybrook & Women's College Health Sciences Centre, Toronto, Ontario, Canada; ²University of Western Ontario, London, Ontario, Canada; ³York University, Toronto, Ontario, Canada; ⁴University of Toronto, Toronto, Ontario, Canada

Somatosensory attention depends on a network of brain structures that selectively inhibits (gates) task-irrelevant sensory inputs and facilitates task-relevant inputs. To explore somatosensory gating and the brain structures involved, a tactile fMRI paradigm was tested in ten healthy, young adults. The presence of a left-handed distractor as well as the delay between the right-handed cue and probe were varied in this event-related, delayed tactile discrimination paradigm. Widespread parietal, temporal, frontal, and thalamic activation was observed, suggesting the paradigm’s usefulness for investigating mechanisms of stroke recovery.

17:30 120. Imaging the Immediate Impact of Transcranial Magnetic Stimulation using Functional Magnetic Resonance Imaging at 3T

Sven Bestmann¹, Jürgen Baudewig¹, Hartwig Siebner², John Rothwell², Jens Frahm¹
¹Biomedizinische NMR Forschungs GmbH, Göttingen, Germany; ²University of Kiel, Kiel, Germany; ³Sobell Department of Motor Neuroscience and Movement Disorders, London, UK

Combined TMS-fMRI was implemented at 3T for a more thorough investigation of focal and remote brain activity changes induced by both supra- and subthreshold TMS. Activity changes occurred even after subthreshold repetitive TMS (rTMS, 3.125 Hz, 10s) of the left sensorimotor cortex (M1/S1) in left PmD, bilateral SMA, left thalamus and putamen. A decrease in the contralateral M1/S1 was found while no local response was detected during subthreshold rTMS. Simultaneous electromyographic recordings confirmed the cortical origin of these activity changes. The data illustrates the capability of TMS-fMRI at 3T to immediately visualise activity changes as induced by TMS.

17:42 121. Temporal Activation Features in Human Motor Cortex During Executed and Imagined Movements

Christian Windischberger¹, Ross Cunnington², Simon Robinson¹, Lüder Deecke¹, Ewald Moser¹
¹University of Vienna, Vienna, Austria; ²University of Melbourne, Melbourne, Victoria, Australia

Eight subjects performed auditory cued executed and imagined finger movements in a event-related paradigm with a image repetition time of 300ms for 4 slices. Using a finite impulse response (FIR) analysis approach we examined the temporal activation pattern in primary motor cortex (M1) and in the supplementary motor area (SMA). Over all subjects, SMA activation was very similar for both conditions, while only minimal M1 activation was detected for imagined movements. During execution trials peak SMA activation was found to precede M1 activation by about 1s, reflecting the fMRI correspondence of the EEG Bereitschaftspotential.

17:54 122. An fMRI Study of Temporal Sequencing of Motor Regulation Driven by an Auditory Cue - A Comparison with Visual Guidance

Toshiharu Nakai¹, Kayako Matsuo¹, Keiichiro Toma², Kenichi Oishi³, Tomohisa Okada², Chikako Kato⁴
¹AIST, Ikeda, Osaka, Japan; ²IBRI, Kobe, Hyogo, Japan; ³Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan; ⁴Toyohashi Sozo College, Toyohashi, Aichi, Japan

The neuronal basis of the higher motor regulation driven by an auditory cue was investigated using fMRI. The activity in the functional network of the SMA, PMA, SPL and cerebellum responded to the demand for the integration of the external auditory cue and internal initiation to generate a complex temporal sequence. The right STG and SMG were more extensively activated by the auditory cue than by the visual cue. It was suggested that these areas are supporting sequence generation triggered by an auditory cue. This observation was in contrast to that with a visual cue.

18:06 123. Influence of Gradient Acoustic Noise on fMRI Response in Human Visual Cortex: A Neuronal Interaction Perspective

Nanyin Zhang¹, Wei Chen¹
¹University of Minnesota Medical School, Minneapolis, Minnesota, USA

Paired-stimuli paradigm combined with dynamic fMRI was utilized to study the effect of gradient acoustic noise on the fMRI response in the human primary visual cortex (V1). The gradient sound during fMRI acquisition was used as the primary stimulus and a single flashing light was used as the secondary stimulus with an inter-stimulus interval (ISI) between them. Six tasks were designed with different ISIs ranging from 50ms to 700ms. Experimental results show that BOLD signals are slightly but significantly suppressed in V1 when the acoustic noise is approximately 300ms preceding the light. This observation should have impact on fMRI applications.

18:18 124. Non-Linear Interactions between Scanner Acoustic Noise and Auditory Stimuli in fMRI

Dave Langers¹, Pim van Dijk¹, Walter Backes¹
¹University Hospital Maastricht, Maastricht, Netherlands

In functional MRI, non-linearities in cerebral hemodynamic responses entail interactions between stimuli; responses in the auditory system, for instance, are particularly affected by scanner acoustic noise. In this study, hemodynamic responses to tone stimuli were measured when a preceding scan was present at varying intervals. From these data the shape of the tonal response could be determined as well as the functional form of the interaction between scanner noise and tone stimuli. The interaction term proved to be proportional to the direct product of the scanner noise response and the tone response, in agreement with a simple non-linear model.
Hemodynamical Aspects and Ischemia in Animal Brain

Room D  16:30 - 18:30  Chairs: Rick M. Dijkhuizen & Claudia Neumann-Haefelin

16:30  I25.  High Resolution Q-maps of Mouse Brain Microvasculature

Ed X. Wu¹, Haiying Tang¹, Jens H. Jensen²
¹Columbia University College of Physicians & Surgeons, New York, USA; ²New York University School of Medicine, New York, USA

MRI is a powerful method for in vivo quantification of tissue properties. It has been previously proposed that the quantity \( Q = \Delta R^2/\Delta R^{2*})^{2/3} \) may be useful for characterizing microvascularity. In particular, \( Q \) is expected to correlate well with the density of microvessels. This study presents in vivo Q-maps of normal mouse brain obtained with a superparamagnetic contrast agent (MION) at 9.4 T. Normative \( Q \) values are derived for various regions and a significant regional variation is observed. Regional microvessel densities estimated from the Q-maps are found to be in reasonable accord with histologically determined values.


Yueh Z. Lee¹, Hongyu An¹, Weili Lin¹
¹University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Exploration of an SE-FID sequence for single scan estimation of cerebral blood volume using an animal model of hypercapnia and contrast injection.

16:54  I27.  Diffusion and Perfusion in Over-Expression Human AChE-Transgenic Mice: Comparison with DNA Microarray

Inbal Eti Biton¹, Eran Meshorer², Yaniv Assaf³, Yoram Ben-Shaul², Hermona Soreq², Yoram Cohen¹
¹Tel-Aviv University, Tel-Aviv, Israel; ²The Hebrew University of Jerusalem, Jerusalem, Israel; ³Tel Aviv Sourasky Medical Center, Tel-Aviv, Israel

The couplings between gene expression and water diffusion in brain are unknown. In this study wild type control (N=19) and over-expressing human acetylcholinesterase (hAChE-Tg) mice (N=20) were used. Chronic excess of synaptic acetylcholinesterase (AChE-S) causes statistically significant suppression of the ADC of water measured in the brain of (hAChE-Tg) as compared with control mice. Contrast-enhanced perfusion MRI indicated poor brain signal recovery following gadolinium-DTPA. DNA microarray analyses unraveled over-expression of numerous ion channels, transporters and cell adhesion proteins. Our study chronic excess of AChE-S may play a central role(s) in the brain's maintenance of balanced water diffusion and ion transport.

17:06  I28.  Effects of Dietary Arginine Supplementation on Cerebral Oxygenation and Perfusion in Sickle Transgenic Mice as Detected by MRI

Richard P. Kennan¹, Sandra M. Suzuka¹, Mary E. Fabry¹, Ronald L. Nagel¹
¹AECOM, Bronx, New York, USA

Nitric oxide (NO) is a powerful vasodilator produced by the action of nitric oxide synthase on arginine and molecular oxygen to form NO and citrulline. NO may be significant in sickle cell disease (SCD) where the vaso-dilatory effects of NO are critical. Patients with SCD and sickle transgenic mice have diminished levels of plasma arginine which may limit NO production. MRI perfusion and BOLD measurements showed that arginine supplementation significantly increased cerebral blood flow and cerebral oxygenation in sickle transgenic mice that express human hemoglobin. These results suggest that dietary arginine supplementation may be an important treatment option in SCD.

17:18  I29.  3D Imaging of Cerebral Blood Flow before and during Global Brain Ischemia and during Reperfusion by using H¹⁷O Tracer and H¹⁷O NMR at 9.4 Tesla

Xiao-Hong Zhu¹, Yi Zhang¹, Wenbo Zhang¹, Wei Chen¹
¹University of Minnesota, Minneapolis, Minnesota, USA

Four-blood vessel occlusion (4BVO) model has been well established for studying hemodynamics regarding global brain ischemia. However, this model requires complete occlusions of common carotid arteries, which poses a challenge in CBF measurements using the arterial-spin tagging MRI methods. We proposed herein to apply fast 3D H¹⁷O MRS imaging combined with H¹⁷O bolus injections for determining CBF distributions before, during and after a 12-minute global ischemia at 9.4T. The results demonstrate that, due to the superior H¹⁷O sensitivity at 9.4T, the proposed method provides a sensitive and reliable imaging approach for perfusion study in brain ischemia.

17:30  I30.  Discrimination of Ischemic Tissue Injury and Blood-Brain Barrier Disruption in Acute Stroke: Magnetization transfer MRI with 2D Cluster Analysis, Quantitative Autoradiography, and Histology

Robert A. Knight¹, Vijaya Nagesh¹, Tavarekere N. Nagaraja¹, James R. Ewing¹, Polly Whitton¹, Susan C. Fagan¹, Quan Jiang¹, Joseph D. Fenstermacher¹
¹Henry Ford Health System, Detroit, Michigan, USA; ²University of Georgia, Augusta, Georgia, USA

This study describes a 2D cluster plot method using magnetization transfer (MT) data to detect ischemic brain regions with and without acute BBB disruption in a rat model of transient focal ischemia that produces BBB injury acutely and hemorrhagic transformation at 24 hours.
17:42  131. Dynamic Tracking of Tissue Fates Using Improved Unsupervised ISODATA Analysis of High-Resolution Quantitative Perfusion and Diffusion Imaging

Hongxia Ren, Qiang Shen, Timothy Q. Duong

1University of Massachusetts Medical School, Worcester, Massachusetts, USA

Ischemic tissue fates were systematically characterized using quantitative perfusion and diffusion imaging during the acute ischemic phase of a rat stroke model. An improved automated, iterative self-organizing data analysis technique (ISODATA) cluster analysis, which can determine the number clusters statistically, was employed to dynamically characterize ischemic tissue fates on a pixel-by-pixel basis on the perfusion-diffusion scatterplots and the image space. Tissue volumes, ADC and CBF values of each cluster were determined at each time points. The evolution of the “perfusion-diffusion mismatch” pixels (tissues at risk) were characterized as they migrated to different clusters as ischemia evolved.

17:54  132. Effects of Reperfusion on Tissue Fates in Acute Stroke Rats: Pixel-by-Pixel Analysis of Quantitative Perfusion and Diffusion Imaging

Qiang Shen, Marc Fisher, Christopher H. Sotak, Timothy Q. Duong

1University of Massachusetts Medical School, Worcester, Massachusetts, USA; 2Worcester Polytechnic Institute, Worcester, Massachusetts, USA

Effects of reperfusion on the spatiotemporal dynamics of transient focal ischemic brain injury in rats were evaluated on a pixel-by-pixel basis using quantitative CBF and ADC measurements every 30 mins for 3hrs. Four biologically relevant clusters (normal, ischemic core, mismatch, non-nourishing reperfusion zone) were classified based on ADC and CBF viability thresholds derived previously. The spatiotemporal progression of tissue volumes, ADC and CBF of each cluster were evaluated. Following reperfusion, 28% of the “core” pixels and 90% of the “mismatch” pixels were salvaged at 3hrs. The ADC and CBF of subsequently salvaged tissues were significantly higher than those became infarcted.

18:06  133. Detection of Iron Oxide Particle-Containing Inflammatory Cells in Developing Infarction by Susceptibility Contrast MRI by Carr-Purcell T2

Martin Kavec, Olli Gröhn, Pia Valonen, Michael Garwood, Risto Kauppinen

1University of Kuopio, Kuopio, Finland; 2University of Minnesota, Minneapolis, Minnesota, USA

Dextrane coated iron oxide particles, e.g. AMI-227, are very efficient T2 contrast agents. Due to long plasma half-life, AMI-227 is taken up by phagocytotic cells in vivo, thus allowing for monitoring invasion of these cells to inflammation site using MR. We have used Carr-Purcell (CP) spin echo MRI acquired with the same echo time and different interpulse interval to reveal local susceptibility gradients generated by intracellular AMI-227. AMI-227 was injected into rats post-stroke and accumulation of phagocytotic cells in developing infarct was monitored. CP-T2 MRI revealed AMI-227 positive cells with high anatomical precision matching histologically detected iron oxide deposits.

18:18  134. Assessment of Treatment Effects with Multiparametric MRI-Based Predictive Algorithms in a Rat Embolic Stroke Model

Ona Wu, Toshihisa Sumii, Minoru Asahi, Masao Sasamata, A. Gregory Sorensen, Leif Østergaard, Bruce R. Rosen, Eng H. Lo, Rick M. Dijkhuizen

1University Medical Center Utrecht, Utrecht, Netherlands; 2Massachusetts General Hospital, Charlestown, Massachusetts, USA; 3Yamanouchi Pharmaceutical Co., Ltd, Tsukuba, Ibaraki, Japan; 4Århus University Hospital, Århus, Denmark

A multiparametric algorithm for predicting infarction in a rat embolic stroke model was trained using acute DWI and PWI from vehicle-treated rats (Group 1). The algorithm was then used to predict infarction in control (Group 2) and treatment (Group 3) arms of a delayed recombinant tissue plasminogen activator trial in rats. In Groups 1 and 2, predicted lesion volumes correlated well with infarct volumes on TTC-stained brain sections (p<.05), but not in Group 3 (p=.6). The latter result is believed to be the result of treatment, indicating the potential of predictive algorithms to assess effects of stroke therapies.

Image Processing and Quantitative Structural MRI of Brain

Room B-1  16:30 - 18:30  Chairs Mark A. van Buchem and Clifford R. Jack

16:30  135. Correction of Transmission and Reception Fields Induced Signal Intensity Nonuniformities In Vivo

Jinghua Wang, Maolin Qu, Qing X. Yang, Michael B. Smith, Todd R. Constable

1Yale University, New Haven, Connecticut, USA; 2The Pennsylvania State University College of Medicine, Hershey, Pennsylvania, USA

Signal intensity (SI) nonuniformity becomes a significant problem for high field MRI. Intensity nonuniformities misrepresent quantitative information and compromise diagnostic scan quality. A simple method is demonstrated for correcting the nonuniformity artifact based on the transmitted field and reception sensitivity maps determined with either gradient (GE) or spin (SE) echo imaging. In a uniform phantom, this approach reduces nonuniformity from 30% before correction to approximately 6% with the SE and 9% with the GE approach after correction. The application of the SE approach is demonstrated in vivo at 3 Tesla.
Multi-Site Structural MRI Studies: An Evaluation of Image Distortions and Image Intensity Reproducibility

Jorge Jovicich, Douglas Greve, Elizabeth Haley, David Kennedy, Yasunari Tosa, Randy L. Gollub, Bruce Fischl, Anders Dale, Brain Morphometry BIRN

Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA; Brain Morphometry BIRN, www.nbirn.net, BIRN, USA

Brain Morphometry Biomedical Informatics Research Network is a group of seven research institutions examining neuroanatomical correlates of neuropsychiatric illnesses. One of the goals of this testbed is to standardize and calibrate structural MRI acquisition protocols to facilitate precise, quantitative evaluation of imaging data using segmentation/morphometry tools from any of the imaging sites, minimizing dependence on site-specific factors. This abstract describes: a) a method for characterizing and correcting site-specific MRI distortions, b) a common structural MRI acquisition protocol for multi-site morphometry studies, and c) an evaluation of image intensity test-retest reproducibility, within-site (important for longitudinal studies), across-site (important for multi-site studies).

SNR and CNR Measurements in the fBIRN Multicenter Study

Vincent Alfonso Magnotta, Lee Friedman

The University of Iowa, Iowa City, Iowa, USA; The MIND Institute, Albuquerque, New Mexico, USA; National Center for Research Resources, Bethesda, Maryland, USA

SNR and CNR measurements were obtained in five subjects across six scanners utilized in the fBIRN protocol. The scanners field strength ranged from 1.5T to 4T. SNR values for grey matter and CNR measurements for grey matter/white matter were obtained in T2 weighted images on each of the scanners. Scans were repeated within a 48 period providing scan rescan measurements. The SNR and CNR measurements were constant across sites at 1.5 T utilizing different vendor hardware and coil RF coil designs. Increasing field strength resulting in a significant improvement in both the SNR and CNR.

Fully Automatic Lobe Delineation for Regional White Matter Lesion Load Quantification in a Large Scale Study

Faiza Admiraal Behloul, Hans Olofsen, Dominique M. van den Heuvel, Nicole Schmitz, J H C Reiber, Mark A. van Buchem

Leiden University Medical Center, Leiden, Netherlands

The goal of this work was to develop an accurate fully-automated brain stripping and lobe delineation method to quantify cerebral White Matter Lesion (WML) load per lobe in a large study on geriatric subjects. A fully automatic template-based approach has been implemented and evaluated on 1054 subjects. The system showed very high reliability (Intra class correlation coefficient of 0.949). This large data set has been processed fully automatically within 15 hours on a Pentium4 computer.

A Study of Lateral Ventricular Asymmetry in Schizophrenia

Kolawole Oluwole Babalola, Jim Graham, Bill Honer, Lili Kopala, Donna Lang, Robert Vandorpe

University of Manchester, Manchester, UK; University of British Columbia, Vancouver, British Columbia, Canada; Dalhousie University, Halifax, Nova Scotia, Canada

We have analysed the degree of shape asymmetry between left and right lateral ventricles of a group of schizophrenic patients and a control group using paired linear discriminant analysis on shape features derived from a three-dimensional Point Distribution Model (PDM). The scalar values obtained by the projection of shape parameters onto the discriminant vector give a quantitative measure of global shape asymmetry for both groups. The PDM paradigm also allows us to localise the areas of asymmetry for both groups on the surface of the ventricles giving a highly specific description of the nature of shape asymmetry.

Neuroanatomical Correlates of Late-Life Minor Depression

Anand Kumar, Martina Ballmaier, Daniel Pham, Jim Mintz, Arthur Toga

UCLA, Los Angeles, California, USA

Minor depression in late-life is a highly prevalent disorder whose anatomical substrates remain largely unknown. We examined regional prefrontal volumes using MRI in a sample of 20 patients diagnosed with minor depression and 28 non-depressed controls. We examined gray and white matter volumes in the following regions - anterior cingulate, orbitofrontal and gyrus rectus using established anatomical boundaries and an automated segmentation program. Gray and white matter volumes in the right anterior cingulate region were smaller in our minor depression group when compared with the controls. These findings have broad biological implications for the neurobiology of mood disorders in late-life.
17:42 141. Brain Segmentation and Structural Multiparametric Analysis for Cortical Malformations Detection in Focal Epilepsy
Frederic Cervenansky¹, Damien Dufournel¹, Nicolas Costes², Philippe Ryvlin¹, Dominic Sappey-Marinier²
¹Université Claude Bernard, Lyon, France; ²CNRS, Lyon, France

With the advent of high resolution MRI, malformations of cortical development (MCD) are increasingly detected and recognized as the underlying cause of seizure in patients with intractable focal epilepsy. Processing tools including brain extraction, tissue classification and structural multiparametric analysis (SMA) are developed to enhance MCD detection on conventional MRI. The SMA application on five T1w-MRI patients point out MCD lesions that are undistinguishable from normal gray matter.

17:54 142. Fully Automatic White Matter Lesion Load Quantification in Geriatric Subjects
Faiza Admiraal Behloul¹, Hans Olofsen¹, Dominique M J van den Heuvel¹, Ad C G M van Es¹, W M. Palm¹, J H C Reiber¹, Mark A. van Buchem¹
¹Leiden University Medical Center, Leiden, Netherlands

The goal of this work was to develop a fast, accurate and fully-automated White Matter Lesion (WML) load quantification in MR images of geriatrics. A maximum time window of 5 minutes per patient was set. The algorithm has been tested on 100 patients. Beside the fact that the approach presented very high agreement with experts (intra-class correlation coefficient of 0.91), the software did not require, in average, more than 2 minutes per patient on a Pentium 4 processor.

18:06 143. Visualization of Thalamic and Pallidal Complex Nuclei using High-Resolution, Multi-Averaged T₁ Maps
Sean CL Deoni¹, Brian K. Rutt¹, Terry M. Peters¹
¹Robarts Research Institute, London, Ontario, Canada

Previous studies at 1.5T and 4T have shown subtle contrast differences within the thalamus and globus pallidus that differ depending on field strength, suggesting possible variations in T1 and/or T2 between the constituent nuclei. In this study we examine the hypothesis that T1 differences exist by mapping T1 throughout the deep brain with 700µm isotropic resolution. We show T1 differences do exist within the thalamus and globus pallidus and can be used to help delineate the major nuclei of these structures.

18:18 144. MRI-Based Brain Volumetry - Dynamic Measurements under Various Ventilation Conditions
Michael Moche¹, Harald Busse¹, Wolfgang Heinke¹, Christos Trantakis¹, Thomas Kahr¹, Horst K Hahn²
¹University of Leipzig, Leipzig, Germany; ²Center for Medical Diagnostic Systems and Visualization, Bremen, Germany

Ventilation-induced changes in the intracranial compliance are typically measured with invasive brain pressure sensors. The aim of the study was to derive brain volumes from interventional MRI measurements and to assess slight changes under therapeutically relevant hyperventilation conditions. The brain of six patients undergoing brain tumor surgery in the open MR were scanned before skull opening under normo- and hyperventilation. Volumetry based on a watershed transformation and an automatic histogram analysis. For moderate reduction in end-tidal CO2-concentration, the brain volume decrease (p<0.05) correlated with the degree of hyperventilation. A further reduction down to 27 mmHg did not yield any significant further reduction.

Dynamic Contrast MR in Clinical Cancer: Theory and Applications
Room B-2  16:30 - 18:30          Chairs: Arend Heerschap and Shinji Hirohashi

16:30 145. A Unified Pharmacokinetic Theory for Intravascular and Extracellular CRs
Xin Li¹, William D. Rooney², Charles S. Springer, Jr. ³
¹Oregon Health & Science University, Portland, Oregon, USA; ²Brookhaven National Laboratory, Upton, New York, USA

A unified theory has been constructed that can accommodate the analysis of T1-weighted 1H2O magnetization during the passage of an intravascular contrast reagent (CR), or one that extravasates. This is done by combining the Kety pharmacokinetic equation with the Bloch equations modified for two coupled equilibrium exchanges of water between three sites (blood, interstitium, cytoplasm). It is shown that this theory can simulate observed behaviors for either limit of CR permeability.
16:42 146. Is There Any Advantage in Looking at More Than Just IAUC for Characterising Tumour Microvasculature?
Caleb Roberts1, Basma Issa1, Sue Cheung1, Alan Jackson1, John C. Waterton2, Geoff J. M. Parker1
1University of Manchester, Manchester, UK; 2AstraZeneca, Alderley Park, Cheshire, UK

We applied compartmental modelling and model-free techniques to extract microvascular characteristics in a range of tumours using contrast-enhanced MRI (DCE-MRI). Model-free approaches are easily implemented but compartmental modelling approaches provide additional and valuable information regarding the underlying physiology. We aimed to compare each approach to assess whether more sophisticated approaches provided reproducibility suitable for use in clinical drug trials. Our results suggest that application of compartmental modelling to DCE-MRI data produces more informative and equally robust summary kinetic tumour parameters in clinical trial conditions.

16:54 147. Reducing Inter-Reader Variability in MRI Perfusion Assessment Through Automated AIF Detection
Edward Ashton1, Jeffrey Evelhoch2, Teresa McShane3
1VirtualScopics, LLC, Webster, New York, USA; 2Pfizer Global Research and Development, Ann Arbor, Michigan, USA; 3Pfizer Global Research and Development, Groton, Connecticut, USA

A method is presented for the calculation of perfusion parameters in dynamic contrast enhanced MRI. Inter-operator variability in the derived rate constant between blood and extra-cellular extra-vascular space is assessed using semi-automated tumor margin identification with both manual and automated blood identification. An assessment is made of the contribution to total variability made by differences in tumor margin identification and differences in blood identification. Experimental results show a mean coefficient of variability (CV) for parameter measurement with manual blood identification of 20.1%, with a mean CV for parameter measurement with automated blood identification of 6.7%.

17:06 148. Relation between Dynamic Gadolinium Uptake Rate, Tumor Vasculature and Tumor Hypoxia in Human Colorectal Liver Metastases
Hanneke van Laarhoven1, Jasper Lok1, Mark Rijpkema1, Cornelis Punt1, Theo Ruers1, Johannes Kaanders1, Albert van der Kogel1, Arend Heerschap1
1UMC Nijmegen, Nijmegen, Netherlands

Assessment of tumor vasculature by dynamic contrast enhanced MRI (DCE-MRI) may provide a useful non-invasive measure for the prediction of treatment outcome and the follow up of chemotherapy. The aim of our study was to validate DCE-MRI as a method to characterize tumor vasculature in colorectal livermetastases. We found a positive correlation between the Gadolinium-DTPA uptake rate kep measured by DCE-MRI and vascular density measured immunohistochemically, indicating that kinetic parameters of DCE-MRI provide a valuable tool for the in vivo assessment of tumor vasculature in colorectal liver metastases.

17:18 149. Comparison of Endothelial Permeability Surface Area Product, ktrans, Derived by Steady-State T1 and First-Pass T2* Methods for Brain Tumors
Lucie Yang1, Soonmee Cha1, Glyn Johnson2, Annie Lai1, Mike F. Wendland1, William P. Dillon1
1University of California, San Francisco, San Francisco, California, USA; 2New York University Medical Center, New York, USA

Noninvasive quantitative measurement of capillary permeability, ktrans, using dynamic contrast-enhanced MR imaging has been shown to correlate with histologic grade of gliomas and may also predict tumor behavior and prognosis. We investigated a recently described dynamic first-pass T2*-weighted method for calculating ktrans in 27 patients with either gliomas or meningiomas and compared these values with those derived by a steady-state T1-weighted method based on a two-compartment model described by Tofts and Kermode. Good linear correlation between ktrans values determined by the two methods was obtained for gliomas but not for meningiomas.

17:30 150. Volume of Bolus Tracking Perfusion Abnormality Predicts Emergence of Contrast Enhancement in Glioblastoma Multiforme
Forrest W. Crawford1, Soonmee Cha1, Janine M. Lupo1, Pooja A. Sadarangani1, Mitchell S. Berger1, Susan Chang1, William P. Dillon1, Sarah J. Nelson1
1UCSF, San Francisco, California, USA

Fourteen patients with glioblastoma multiforme were studied to determine whether the volume of residual bolus tracking perfusion abnormality after surgery but immediately before irradiation (XRT) could predict the volume of contrast enhancement after XRT. There were significant correlations between the volume of pre-XRT perfusion abnormality and post-XRT contrast enhancement (R²=0.854) and two months post-XRT (R²=0.934). However, no correlation between pre-XRT and post-XRT contrast enhancement volume was seen. The pre-XRT perfusion abnormality may serve as a better target for radiation therapy planning and the emergence of contrast enhancement following XRT may represent changes in tumor microvasculature.
17:42  **151. Assessment of Angiogenesis-Induced Hemodynamic Abnormalities in Brain Tumors using Intravoxel Transit Time Distributions**
Christopher Chad Quarles¹, Doug Ward¹, Kathleen M. Schmainda¹
¹Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Using a combined GE/SE DSC perfusion method we demonstrate the potential of intravoxel transit time distributions (TTDs) as a novel measure of tumor hemodynamic heterogeneity. TTDs were compared in the normal and tumor tissue of a rat brain tumor model. The maximum differences between the cumulative normal and tumor TTDs are introduced as a method to quantify differences between the TTDs. There were substantial differences between mean normal and mean tumor TTDs. The maximum difference maps showed hemodynamic heterogeneity both within and around the primary tumor mass, outside the contrast-enhancing area.

17:54  **152. Evaluation of Vessel Size Heterogeneity in Brain Tumors with Dynamic Contrast-Enhanced Dual Echo Perfusion Imaging**
Melina Pectasides¹, Thomas Benner², Christopher J. Wiggins³, Chloe Joan Lopez¹, Hakan Ay¹, Fred H. Hochberg¹, Bruce R. Rosen¹, A. Gregory Sorensen¹
¹Massachusetts General Hospital, Boston, Massachusetts, USA

We investigated the vessel size heterogeneity of brain tumors with the acquisition of simultaneous GE/SE dynamic contrast-enhanced perfusion weighted images in a collection of brain tumor patients. We found that, in 6 of 9 patients, rCBV values in certain areas of the tumor were greater by more than 50% on GE compared to SE derived maps. Other areas of the same tumor had essentially similar rCBV values on the two kinds of maps. Vessel size maps were also created and gave similar results. We speculate that the different areas observed within the tumor might have different characteristics and behavior.

18:06  **153. Analysis of Serial Changes in Perfusion Parameters for Patients with Recurrent High Grade Gliomas being Treated with Radiosurgery**
Antoinette Antiniw Chan¹, Andrea Pirzkall¹, Sarah J. Nelson¹
¹University of California, San Francisco, California, USA

Nine recurrent malignant glioma patients undergoing Gamma Knife (GK) radiosurgery were evaluated on a voxel-by-voxel basis using perfusion parameters derived from dynamic susceptibility contrast (DSC) imaging. Median values from follow-up exams were compared to pre-GK values by utilizing the Kruskal-Wallis test. For voxels within the 25% isodose line (IDL), relative cerebral blood volume (rCBV) and peak height (rPH) significantly and continually decrease two months post-GK. Voxels within the 50% IDL exhibit a significant increase in relative leakage (rL) two months post-GK and then a trending decrease six months post-GK. These patterns may elucidate the effects of radiation therapy on microvasculature.

18:18  **154. Dynamic Contrast-Enhanced MRI (dceMRI) Evaluation of the Effects of the VEGF/PDGF Receptor Tyrosine Kinase Inhibitor AG-013736 on Tumor Vasculature in a Phase I Clinical Trial**
Teresa McShane¹, Edward Ashton¹, Edward Jackson¹, Frederick Kelcz¹, Benjamin Yeh¹, Chaun Ng¹, Chusilp Charnsangavej¹, Heidi Steinfeld⁵, Steve Reich⁵, Yazdi Pithavala⁷, Jeffrey Evelhoch⁷
¹Pfizer Global Research & Development, Groton, Connecticut, USA; ²VirtualScopics, Rochester, New York, USA; ³University of California, San Francisco, California, USA; ⁴University of San Francisco, San Francisco, California, USA; ⁵Pfizer Global Research & Development, La Jolla, California, USA; ⁶Pfizer Global Research & Development, Ann Arbor, Michigan, USA

Initial area under the curve (IAUC) and Ktrans were calculated from dynamic contrast-enhanced MRI (dceMRI) data in a Phase I clinical trial of AG-013736, a selective inhibitor of VEGFR/PDGFR tyrosine kinases. IAUC and Ktrans measured before and at definite time points after 2-3 doses of AG-013736 were reduced by >50% in 5/14 patients, and by >30% in 11/14 patients. Two out of 5 pts with >50% decrease in both Ktrans and IAUC at Day 2 also demonstrated a partial clinical response after 8 weeks of treatment. DceMRI provides an objective measure of vascular response to anti-tumor agents targeting angiogenesis.
JAPANESE LANGUAGE SUMMARY SESSION
Basic Science Highlights
Room B-1 18:30 – 20:00

JAPANESE LANGUAGE SUMMARY SESSION
New Clinical Developments
Room B-2 18:30 – 20:00

STUDY GROUP
Diffusion and Perfusion MR
Main Hall 18:30 – 20:00

Business Meeting and Announcements
Debate on Splitting the Study Group
Perfusion Workshop Highlights
Diffusion Workshop Planning
Artifact Gallery

STUDY GROUP
MR Flow and Motion Quantitation
Room A 18:30 – 20:00

Meet and Greet
Business Meeting
Six 5-minute Poster Presentations
Invited Presentation on Elastography
OR Two 10-minute Commercial Software Presentations

STUDY GROUP
Molecular and Cellular Imaging
Annex 1 18:30 – 20:00

The Molecular and Cellular Imaging Study Group will present a scientific program.
STUDY GROUP
High Field Systems and Applications

Annex 2 18:30 – 20:00

Business Meeting
Update on Plans for Study Group Website
Discussion on Renewal of Study Group, Anticipating Expiration
Call for Nominees for 2005 Study Group Officers

Scientific Program
• Update on High Field Safety Issues
  Speaker to be announced

• Clinical Potential of High Field MR: What Works and What Doesn’t
  Robert R. Edelman, M.D., Evanston Northwestern Healthcare, Evanston, Illinois, USA
  Speaker to be announced

• Managing SAR using Novel RF Design
  Jürgen Hennig, Ph.D., University of Freiburg, Freiburg, Germany

STUDY GROUP
Musculoskeletal Imaging

Sakura 18:30 – 20:00

The Musculoskeletal Imaging Study Group will hold a Business Meeting and present a scientific program.

STUDY GROUP
Hyperpolarized Noble Gas MR

Room D 18:30 – 20:00

Scientific presentation by David Lipson, M.D., University of Pennsylvania, Philadelphia, Pennsylvania, USA

Scientific presentation by Jim Snapper, M.D., GlaxoSmithKline
MORNING CATEGORICAL COURSE
Functional Body MR: From Morphology to Function

Sakura 07:00 – 08:00 Chairs: Riccardo Manfredi and Carlo Bartolozzi

Educational Objectives
Upon completion of this course, participants should be able to:
• Evaluate new pulse sequences based on knowledge of current MR technique, and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Incorporate recent developments for MR imaging such as MRCP for the pancreas and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Apply new contrast agents in different hepatic diseases;
• Evaluate the possibility of MR imaging in bowel imaging and in screening oncologic patients for metastatic disease;
• Achieve functional information reflecting physiologic processes.

07:00 Perfusion and Diffusion Techniques in Body Imaging
Joseph C. McGowan

07:30 Body Imaging at 3T
Kimberly Amrami

MORNING CATEGORICAL COURSE
Understanding Diffusion Imaging and Functional MRI: The Relationship between Structure and Function in the Brain

Room A 07:00 – 08:00 Chairs: Gareth J. Barker and R. Todd Constable

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain how the fMRI data are acquired and processed;
• Explain how the diffusion tensor is acquired, measured and mapped;
• Define the terms structural and functional connectivity;
• Describe sources of artifacts, limitations to the data, and the likely impact of new parallel imaging techniques on fMRI and DTI data;
• List methods available to combine the complementary information from fMRI and DTI data.

The final five minutes of each presentation will be reserved for questions.

Introduction to fMRI
07:00 fMRI Basics: Paradigm Design/Analysis
R. Todd Constable

07:30 fMRI Resting State Connectivity/Structural Equation Modeling
Mark J. Lowe

MORNING CATEGORICAL COURSE
Echo Management

Room D 07:00 – 08:00 Chairs: Kim Butts and Scott D. Swanson

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain the basic principles of spin echo, gradient echo, and stimulated echo formation;
• Appreciate the complexity of coherence pathways that arise when two or more RF pulses are applied;
• Describe methods that investigators use to mitigate effects of multiple coherence pathways to assure formation of proper echoes;
• List techniques used in steady-state free precession (SSFP) pulse sequences to minimize spurious echo formation;
• Determine which sequence will be appropriate for what clinical application.

07:00  **Basic Principles of Echo Formation**  
*R. Scott Hinks*

07:25  **Basics of Echo Formation: Refocused**  
*James B. Murdoch*

07:50  **Discussion**

**MORNING CATEGORICAL COURSE**

**Established and Evolving Applications of MR Angiography**

Annex 2  07:00 – 08:00  Chairs: J.F.M. Meaney, M.R. Prince, S.O. Schoenberg

**Educational Objectives**
Upon completion of this course, participants should be able to:
• Define the established indications for MRA;
• Recognize the importance of non-contrast and contrast-enhanced approaches in the different vascular territories;
• Diagnose common vascular pathology and variants;
• Apply the different post-processing algorithms to enhance diagnostic practice;
• Perform basic vessel wall imaging.

**Body MRA**
07:00  **Thoracic Aorta MRA**  
*Mitsue Miyazaki*

07:20  **Abdominal MRA**  
*Thomas M. Grist*

07:40  **Coronary MRA**  
*Scott D. Flamm*

**MORNING CATEGORICAL COURSE**

**New Horizons in Musculoskeletal Imaging: Optimizing MRI With Current Technology**

Room B-1  07:00 – 08:00  Chairs: Joshua M. Farber and Lawrence M. White

**Educational Objectives**
Upon completion of this course, participants should be able to:
• Describe MR techniques for imaging cartilage at various field strengths and understand the clinical role of MRI in the evaluation of articular cartilage disorders;
• Assess the musculoskeletal system using high and low field MR systems;
• Explain and use fat suppression MRI techniques in the musculoskeletal system;
• Explain and use fast scanning MRI techniques in the musculoskeletal system;
• Apply knowledge of high resolution MRI, and its trade-off with signal-to-noise, to imaging the musculoskeletal system;
• Describe the rationale of protocol approaches and apply this understanding to optimize MRI clinical protocols.

07:00  **MRI of Cartilage - Technical Considerations**  
*Timothy J. Mosher*
07:25  MRI of Cartilage - Clinical Applications and Imaging Evaluation  
       Carl S. Winalski

07:50  Discussion

MORNING CATEGORICAL COURSE
Parallel Imaging 2004

Annex 1  07:00 – 08:00  Chairs: Neil M. Rofsky and Daniel K. Sodickson

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain the basic principles of parallel imaging, including elements both of RF coil array design and image reconstruction;
• Critically survey promising applications of parallel MRI;
• Summarize recent research into the limits of performance of parallel imaging, describe new developments in image reconstruction and coil array design, and outline emerging parallel imaging applications;
• Identify the key steps in a practical parallel imaging examination, and compare the nuts-and-bolts features of various MR vendors' existing implementations.

Basics
07:00  Introduction  
       Daniel K. Sodickson

07:05  Coil Arrays (The Technological Tools)  
       Michael Ohliger

07:30  Image Reconstruction (The Mathematical Tools)  
       Klaas Prüssmann

07:55  Discussion

MORNING CATEGORICAL COURSE
MR Spectroscopy: The Brain and Beyond

Room B-2  07:00 – 08:00  Chairs: Peter S. Allen, John R. Griffiths, Rolf Gruetter

Educational Objectives
Upon completion of this course, participants should be able to:
• Describe the principles of spectral analysis through LC modeling;
• Outline the mechanisms for intra-sequence signal loss when target metabolites have coupled spins;
• List the key metabolites facilitating the spectroscopic recognition of tumor development in the prostate and the brain;
• Outline how water can be used as an internal concentration standard with minimal associated spectral artifacts;
• Explain how macromolecular contamination of spectra can be recognized and mitigated;
• Explain how MRS can be used to reflect metabolic processes in muscle using glycogen or lipids.

07:00  The LC Modeling Approach  
       Pierre-Gilles Henry

07:20  Discussion

07:30  Coupled-Spin-Metabolite Signal Yield  
       Peter S. Allen
PLENARY LECTURES
MRI Beyond Tissue Anatomy with Novel Contrast Agents
Main Hall     8:15 - 9:30               Chair: Sebastián Cerdán

8:15   155. MRI of Biochemical Variables with Novel Contrast Agents
         A. Dean Sherry¹
         ¹University of Texas, Dallas, Texas, USA

Next generation MR imaging agents will report specific biochemical variables like enzyme activity, gene expression, pH, redox, tissue oxygenation, metabolite levels and other indices of metabolism. Several approaches can be taken in the design of biochemically responsive imaging agents. One can alter the T1 of bulk water using paramagnetic complexes of Gd(III), T2 using various formulations of iron oxide or other nanoparticles, or the total bulk water signal using a paramagnetic chemical exchange saturation transfer (PARACEST) agent. This lecture will review design concepts and show examples of responsive MR imaging agents that are sensitive to tissue physiology and metabolism.

8:40   156. Blood Pool Contrast Agents
         Robert M. Weisskoff¹
         ¹EPIX Medical, Inc., Cambridge, Massachusetts, USA

Blood pool (BP) agents are a new class of contrast agents that are designed to enhance the imaging properties of blood, and have considerably different pharmacokinetic and imaging characteristics than currently available agents. This talk reviews the different types of BP agents, and discusses the properties that allow them to enhance blood preferentially. The initial applications of BP agents will be described, including body MR angiography (MRA) and coronary angiography. In addition, applications are emerging that exploit the biodistribution, kinetics, or imaging characteristics of BP agents. These applications include tumor and angiogenesis imaging, imaging vessel inflammation, lymphangiography, and functional imaging.

9:05   157. Stem Cell Tracking in Physiology and Pathology
         Mathias Hoehn¹
         ¹Max-Planck-Institute for Neurological Research, Cologne, Germany

This presentation focusses on the potential of in vivo MR microscopy for the observation of stem cell dynamics in a host organ. For this purpose, the established immunohistochemical and microscopical approaches are discussed and compared with the strategies for the in vivo MRI detection of stem cells. Applications to ischemic heart muscle and cerebral ischemia will be demonstrated and used to discuss potential and limits of the in vivo MR approach. Finally, a subjective analysis of future potential and synergistic needs of the technique as a Molecular Imaging contribution will be given.

Labeling and Tracking of (Stem) Cells
Main Hall     10:30 - 12:30               Chairs: Mathias Hoehn and Joseph A. Frank

10:30   158. MRI of Magnetically Labeled Endothelial Precursor Cells to Non-Invasively Image Neovasculature in a Mouse Glioma Model
         Stasia A. Anderson¹, John Glod², Ali S. Arbab¹, Martha Noel¹, Parwana Ashari¹, Howard A. Fine¹,
         Joseph A. Frank¹
         ¹National Institutes of Health, Bethesda, Maryland, USA; ²Cancer Institute of New Jersey, New Brunswick, New Jersey, USA

We magnetically labeled endothelial precursor cells (EPCs) from bone marrow and imaged the homing of these cells to tumor in a glioma model, where they are incorporated selectively into the neovasculature. MR directly detected the angiogenesis associated with tumor growth. The homing behavior makes EPCs possible gene delivery vectors, and the ability to image these cells in vivo provides a method that can be used to monitor, optimize, and assess effect in antiangiogenic gene therapy of tumors.

10:42   159. In Vivo MR Tracking of Magnetically Labeled Neural Spheres Transplanted in Chronic EAE Mice: Relation between Cell Migration and Inflammation
         Tamir Ben-Hur¹, Ruud van Heeswijk¹, Ophira Einstein², Rong Xue¹, Emma Frost¹, Sasumu Mori¹,
         Benjamin E. Renbino², Jeff W.M. Balte³
         ¹Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; ²Hadassah University Hospital, Jerusalem, Israel

We transplanted magnetically labeled mouse and human neural spheres in the brains of mice with chronic EAE. Using serial MRI, we determined the speed of migration into white matter tracts, and correlated the distance with the observed neurological symptoms. For the syngeneic model, we found that inflammatory signals associated with the clinical score modulate cell migration in a positive manner.
Magnetic Resonance Imaging of Murine EG-Derived Neural Stem Cells in Mouse Lower Motoneuron Paralysis

Juhana M. Hakumäki1, Jeff W. M. Bulte1, Michael J. Shamblott1, Jiangyang Zhang1, Trevor Douglas3, Peter C. M. van Zijl1, John D. Gearhart1, Douglas A. Kerr1
1Johns Hopkins University, Baltimore, Maryland, USA; 2Montana State University, Bozeman, Montana, USA

In this study, we used murine neural stem cells to investigate their migration in the spinal cord, as well as their restorative potential in a virally induced mouse model of lower motoneuron injury and paralysis. Functional recovery was observed for treated animals, and migration of magnetodendrimer-labeled cells into lesioned ventral horns of the spinal cords could be observed by MRI.

Magnetic Labeling of Human Bone Marrow Stromal Cells and their Imaging after Transplantation: An In Vivo Animal Study

Vít Herynek1, Pavla Jendelová2, Katerina Glogarová2, Lucia Urdziková3, Daniel Jiráč1, Milan Hájek1, Eva Syková1
1Institute for Clinical and Experimental Medicine, Prague, Czech Republic; 2Center for Cell Therapy and Tissue Repair, Prague, Czech Republic; 3Institute of Experimental Medicine ASCR, Prague, Czech Republic

We labeled human bone marrow stromal cells with the superparamagnetic contrast agent Endorem to enable their monitoring in vivo using MRI. Cells were injected intravenously into rats with an experimental photochemical cortical lesion. Different numbers of cells were transplanted. MRI showed that the cells migrated into the lesions. The presence of cells in the lesions was confirmed by histology.

A Serial MRI and Behavioral Assessment of Neural Stem Cell Therapy in the 3-Nitroprorionic Acid Model of Huntington's Disease.

Toby J. Roberts1, Jack Price1, Steven C. R. Williams1, Michel M. Modo1
1Institute of Psychiatry, King's College London, London, UK

To investigate the anatomical and behavioural effects we followed rats with 3-nitroprorionic acid-induced bilateral striatal lesions over 16 weeks and determine to what degree the transplantation of neural stem cells will recover lost function and its neurological correlates. We found that there was significant behavioural effect on the beam walk test and a partial recovery on the water maze. Serial MRI highlighted that there was no reduction in lesion volume over time due to stem cell transplantation, but grafts significantly reduced striatal tissue loss suggesting that neural stem cell transplantation prevents further neurodegeneration rather than de novo tissue formation.

Positive Contrast Labelling of SPIO Loaded Cells in Cell Samples and Spinal Cord Injury

Andrew J. Coristine1, Paula Foster1, Sean C. L. Deoni1, Chris Heyn1, Brian K. Rutt1
1Robarts Research Institute, London, Ontario, Canada

Very high resolution images of super-paramagnetic iron oxide (SPIO) loaded macrophages, suspended in gelatin, were acquired using a “white-marker” SPGR sequence, which yielded a purely positive contrast label. A high performance insert gradient and small solenoid RF coil were used in conjunction with a 1.5 T clinical scanner to acquire 100x100x200 μm³ voxels. The technique was then applied to a rat model of spinal cord injury to test its use in ex vivo imaging. The WM sequence was particularly successful in distinguishing between signal loss caused by air or hemorrhage and that caused by iron-loaded cells.

In Vitro Cell Labeling for Manganese Enhanced Magnetic Resonance Imaging

Ichio Aoki1, Yoshiyuki Takahashi2, Kai-Hsiang Chuang2, Takehito Igarashi2, Afonso C. Silva1, Chizuo Tanaka2, Richard W. Childs1, Alan P. Koretsky1
1National Institutes of Health, Bethesda, Maryland, USA; 2Meiji University of Oriental Medicine, Hiyoshi, Kyoto, Japan

The ability of adoptively infused tumor specific T-cells and NK-cells to traffic to the tumor microenvironment may be a critical determinant of their therapeutic efficacy. We tested the hypothesis that lymphocytes and B-cells would label with MnCl₂ to a level that would allow their detection by MRI. Significant signal enhancement was observed in lymphocytes after incubation with 0.05-1.0mM MnCl₂. No apoptosis or necrosis was observed up to 0.5mM MnCl₂. The killer activity of both NK-cells and cytotoxic T-cells were not significantly affected. This is the first report to describe the use of MnCl₂ to label lymphocytes.

Detectability Threshold of Single SPIO Loaded Cells Using FIESTA

Chris Heyn1, Christopher V. Bowen1, Brian K. Rutt1, Paula Foster-Gareau1
1Robarts Research Institute, London, Ontario, Canada

Utilizing numerical simulations and methods for MRI and optical verification of single or multiple cells, we studied the signal behavior of the FIESTA pulse sequence for voxels containing SPIO-labeled cells. Through this analysis, we developed a relationship that predicts the threshold of SPIO detection for single cells using the FIESTA pulse sequence as a function of image resolution and SNR. This work will greatly simplify the design of single cell detection experiments, since the optimal resolution and required SPIO loading levels may be derived using only a measure of tissue SNR for any combination of RF coil and field strength.
Molecular and cellular imaging have made a tremendous impact in the last few years for monitoring short term cell migration and homing. Here we demonstrate that micron size iron oxide particles (MPIO’s) are useful for studying long term engraftement of hepatocytes. Hepatocytes labeled with MPIO’s are visible in mouse livers one month and one year post-transplantation. We also demonstrate their usefulness for in vivo labeling of neural stem cells by direct stereotactic injection into the SVZ. Labeled neural progenitors were visualized along well known migratory pathways as long as 5 weeks following injections.

Human MSCs were labeled with PLL-Feridex and assayed for cellular differentiation both in vitro and in vivo. Labeled MSCs underwent adipogenic and osteogenic differentiation as efficiently as unlabeled cells, but there was a marked inhibition of the in vitro chondrogenesis. The blocking of chondrogenic activity was mediated by the Feridex, rather than by the transfection agent (PLL). Thus, caution should be taken when using Feridex-labeled cells for chondrogenic studies. No evidence of detrimental effects of Feridex on adipogenic or osteogenic transplantation studies was observed.

### CLINICAL CATEGORICAL COURSE

**Interventional MRI: State of the Art and Beyond**

Room A 10:30 – 12:30  Chair: Kim Butts

**Educational Objectives**

Upon completion of this course, participants should be able to:

- List several procedures that are being developed under MRI guidance;
- Describe the types of MR-compatible devices and open MRI systems that are available;
- Describe some of the challenges of using MRI guidance for interventional procedures;
- Compare the value of MRI guidance to other available image-guidance systems.

10:30  **MR-Guided Breast Biopsy**  
*Christiane K. Kuhl*

10:50  **MR-Guided Focused Ultrasound**  
*Kullervo Hynynen*

11:10  **MR-Guided Microwave Therapy of the Liver**  
*Shigehiro Morikawa*

11:30  **MR-Guided Neurosurgery**  
*Christopher Nimsky*

11:50  **MR-Guided Vascular Interventions**  
*Elliot R. McVeigh*

12:10  **Discussion**

12:30  **Adjournment**
Myocardial Viability: From Pulse Sequences to Patients

Annex 1  10:30 - 12:30        Chairs: Andrew E. Arai and David A. Bluemke

10:30  168. **High-Resolution T1 Mapping of the Myocardium within a Single Breath-Hold**

Daniel R. Messroghli1, Aleksandra Radjenovic1, Sebastian Kozerke1, David M. Higgins1, Mohan U. Sivananthan1, John P. Ridgway1

1Leeds General Infirmary, Leeds, UK; 2ETH and University of Zurich, Zurich, Switzerland

Background Conventional one-shot T1 measurement techniques are not suitable for cardiac applications on 1.5 T systems because of cardiac motion.

Methods A modified Look-Locker inversion recovery (MOLLI) pulse sequence scheme is presented which introduces selective image acquisition and merging of image sets into the conventional Look-Locker approach. The method is tested in phantoms, in a volunteer and in a patient with myocardial infarction. Results In-vitro studies showed good T1 accuracy over a wide range of T1 and heart rates. In-vivo studies resulted in high-quality T1 maps. Conclusion MOLLI allows for high-resolution T1 mapping of the myocardium within a single breath-hold.

10:42  169. **Motion Corrected Free-Breathing Delayed Hyperenhancement Imaging of Myocardial Infarction**

Peter Kellman1, Andrew C. Larson1, Yiu-Chong Chung1, Orlando P. Simonetti2, Elliot R. McVeigh1, Andrew E. Arai1

1National Institutes of Health, Bethesda, Maryland, USA; 2Siemens Medical Solutions USA, Chicago, Illinois, USA

Following administration of Gd-DTPA, infarcted myocardium exhibits delayed hyperenhancement and can be imaged using an inversion-recovery sequence. Using a conventional segmented acquisition requires a number of breath-holds to image the heart. Single-shot phase-sensitive inversion-recovery (PSIR) true-FISP may be combined with parallel imaging using SENSE to achieve high spatial resolution. Enhanced SNR may be achieved by averaging multiple motion corrected images acquired during free-breathing. PSIR techniques have demonstrated a number of benefits including consistent contrast and appearance over a relatively wide range of inversion recovery times (TI), improved contrast-to-noise ratio, and consistent size of the hyperenhanced region.

10:54  170. **A Magnetic Resonance Technique for Simplified and Simultaneous Imaging of Myocardial Viability and Function using Undersampled Projection Reconstruction**

Orhan Unal1, Tim F. Christian1, Thomas M. Grist1

1University of Wisconsin, Madison, Wisconsin, USA

A fast TrueFISP MR imaging technique that allows retrospective selection of selection of inversion time (TI) to null normal myocardium effectively by taking advantage of the intrinsic oversampling of the center of the k-space in projection reconstruction (PR) acquisition and a sliding-window reconstruction technique with a temporally varying aperture with radial distance is presented.

11:06  171. **Computer Quantification of Myocardial Infarction on Contrast Enhanced Magnetic Resonance Imaging**

Li-yueh Hsu1, Peter Kellman1, Alex Natanzon1, Anthony H. Aletras1, Andrew E. Arai1

1National Institutes of Health, Bethesda, Maryland, USA

We investigate the performance of a computer algorithm to objectively measure infarct size on gadolinium delayed enhancement MRI. Using both magnitude and phase-sensitive reconstruction methods, the results of computer sizing are validated with histopathology studies. This algorithm accurately estimates infarct size on both imaging methods and reduces systematic bias or random errors that may occur with a human observer.

11:18  172. **Repeated, Pixel-By-Pixel T1-Mapping in Canine Myocardial Infarction, Using an Infarct-Avid, Persistent Contrast Agent, Gd(ABE-DTTA)**

Pál Surányi1, Pál Kiss1, Brigitta C. Brott1, Tamás Simor1, Ada Elgavish1, Gabriel A. Elgavish1

1University of Alabama at Birmingham, Birmingham, Alabama, USA

Determining T1 following the administration of an infarct-avid contrast-agent allows the visualization of myocardial infarction in a manner that eliminates many confounders associated with SI. We demonstrate the feasibility of repeated in-vivo T1-mapping in closed-chest canine reperfused infarction, using a single administration of Gd(ABE-DTTA). Pixel-by-pixel T1-maps in six dogs were generated repeatedly, 24h through 96h following administration. Distribution of infarcted versus viable tissue was detected with high-resolution. Infarcted areas with decreased T1 due to agent accumulation were measured in each T1-map. There was significant correlation (P<0.01, R=0.97) between area measurements in T1-maps and area measurements in corresponding postmortem TTC-staining photos.
Regenerative Myocardial Tissue in a Murine Infarction Model

Peter Nabil Costandi, Jeffrey Howard Omens, Andrew D. McCulloch, Lawrence R. Frank

University of California, San Diego, La Jolla, California, USA

The advent of mouse transgenic technology has emphasized the importance of high field murine cardiac imaging. The MRL/MpJ+/+ mouse strain has been shown to regenerate tissue during wound healing and is used in an infarct model. Cardiac MR imaging of high spatial and temporal resolution allows non-invasive, longitudinal assessment of cardiac structure and is used in conjunction with finite element modeling to characterize the potential regenerative aptitude of MRL mice. Initial results suggest the MRL strain of mice has the ability to regenerate myocardial tissue and recover cardiac function after injury.

WITHDRAWN

Intracellular Sodium MRI during Acute Regional Myocardial Ischemia and Reperfusion

Maurits A. Jansen, Marcel G.J. Nederhoff, Cees J.A. Van Echteld

University Medical Center, Utrecht, Netherlands

Due to the rapid changes of Na during ischemia and reperfusion of viable myocardium, 23Na-MRI appears to be an ideal diagnostic modality for early detection of myocardial ischemia and viability. In this study, the value of Na imaging was assessed in acute regional ischemia and reperfusion. Rat hearts were perfused using a dual-perfusion cannula, allowing independent perfusion of both sides of the heart. 23Na-MRI was performed during control perfusion, ischemia of only the left side and reperfusion. The area on the Na-image at end ischemia where relative Na-intensity was above 4% correlated well with the unstained area on the triphenyltertrazolium-image.

Microvascular Obstruction Related to Primary Angioplasty by Magnetic Resonance Imaging with Acute Myocardial Infarction

Hye-Jeong Lee, Byoung Wook Choi, Kyu Ok Choe, Young-Jin Kim, Namsik Chung, Se-Joong Rim

Yonsei University College of Medicine, Seoul, Republic of Korea

Primary angioplasty without preceding thrombolysis is effective in restoring perfusion, but the presence of microvascular obstruction after the procedure is associated with poor clinical outcome. With contrast-enhanced MRI, microvascular obstruction can be detected easily as hypoenhanced region within hyperenhanced lesion in contrast-enhanced MRI. We investigated the prevalence of microvascular obstruction in acute myocardial infarction treated by primary angioplasty compared to those treated by thrombolytic therapy with contrast-enhanced MRI. The occurrence of microvascular obstruction was related with larger transmural extent of infarction. However microvascular obstruction was more prevalent with primary angioplasty than with thrombolytic therapy even under control of infarct size.

Accuracy of Myocardial Viability Assessment by Contrast-Enhanced MRI (Late Enhancement) Compared to Low-Dose Dobutamine Stress Echocardiography

Peter Hunold, Holger Eggebrecht, Thomas Schlosser, Thomas Bartel, Kai-Uwe Waltering, Jörg Felix Debatin, Jörg Barkhausen

University Hospital, Essen, Germany

Aim of the study was to compare “late enhancement” (LE) in contrast-enhanced MRI and low-dose Dobutamine stress echocardiography (LD-DSE) for the assessment of myocardial viability in CAD patients with impaired LV function. In 19 patients, contrast-enhanced IR-turboFLASH MR imaging for LE detection and LD-DSE were performed using the AHA 17-segment model. LD-DSE overestimates the extent of scar tissue compared to contrast enhanced MRI. But many segments without scar in MRI do not improve under low-dose stress. Those segments may represent myocardial areas without regional improvement after revascularization although viable and sufficiently perfused.

Exploiting Endogenous Contrast Mechanisms

Sakura 10:30 - 12:30

Myelin Selective Magnetization Preparation

Adam R. Travis, Mark D. Does

Vanderbilt University, Nashville, Tennessee, USA

Myelin mapping done by decomposing a transverse relaxation signal into a so-called T2-spectrum is experimentally difficult due to B0 and B1 field variation, eddy currents, and the high SNR necessary for computing the T2-spectrum. A potential alternate approach is to use the multi-exponential T1 characteristics of neural tissue. In this way, magnetization preparation, such as inversion-recovery (IR) or multiple-inversion recovery, may provide a more robust method to quantify tissue myelin content. As a first step toward evaluating the efficacy of such a method, IR and double-IR (DIR) preparations have been used in T2 measurement of peripheral nerve water in vitro.
10:42 179. **MR Imaging with \( T_1 \) Dispersion Contrast**

Sharon E. Ungersma, Nathaniel I. Matter, Albert Macovski, Steven M. Conolly, Greig C. Scott

1University of California, Los Angeles, Los Angeles, California, USA

Soft tissue contrast manipulation is one of MRI’s strengths. Prepolarized MRI can polarize a sample at high field, then allow the magnetization to decay at an “evolutionary” field strength before imaging at low field. We image samples at two evolutionary field strengths and subtract the images, yielding an image with contrast reflecting the slope of the \( T_1 \) vs. field dispersion curve, rather than contrast from single values of \( T_1 \). We present a method for creating \( T_1 \) dispersion contrast between fat or unbound water, which have roughly constant \( T_1 \), and muscle tissue, which has rapidly varying \( T_1 \) near the quadrupole dips.

10:54 180. **Quantitative Description of Proton Exchange Processes between Water and Endogenous and Exogenous Agents. The Sensitivity of pH Imaging Using Endogenous Amide Proton Transfer (APT) Contrast**

Jinyuan Zhou, Phillip Zhe Sun, Peter C.M. van Zijl

1Johns Hopkins University, Baltimore, Maryland, USA

The proton exchange processes between water and solutes containing exchangeable protons have recently become of interest for monitoring pH effects, for detecting cellular mobile proteins and peptides, and for sensitivity enhancement of various low concentration endogenous and exogenous species. In this abstract, the analytic expressions for several types of experiments are derived using the Bloch equations with exchange terms. The case of endogenous amide proton exchange in the rat brain at 4.7 T is analyzed in detail.

11:06 181. **Feasibility of Assessing Trabecular Bone Architecture by Intermolecular Double-Quantum Coherence MRI**


1University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA; 2University of Nevada, Reno, Nevada, USA; 3St. Lawrence University, Canton, New York, USA

Intermolecular multiple-quantum coherence (iMQC) MR imaging allows probing tissue microstructure by tuning the direction and strength of the correlation gradient. However, iMQC images of a specific quantum-coherence can be contaminated by leakage from undesired quantum coherences. Using a modified double-quantum CRAZED imaging sequence, we show that signals originating from various coherence orders (\( M=0, 1, 2, 3 \)) can be predicted in k-space and effectively isolated by means of a four-step phase cycling scheme and judicious choice of flip angles. Preliminary data suggest the method to be able to provide information on trabecular bone architecture such as regional mean trabecular plate separation.

11:18 182. **Double Quantum Filtered Magnetization Transfer Imaging By ‘Soft’ Pulses – A Step towards Clinical Application**

Arnon Neufeld, Uzi Eliav, Gil Navon

1Tel Aviv University, Tel Aviv, Israel

In the DQF-MT method (Neufeld et al, MRM 50, 229 (2003)), a new contrast, based on the macromolecular content of biological tissues, is obtained by selective excitation of the macromolecular magnetization that is subsequently transferred to water where the imaging sequence is employed. However, the short pulses required in this method are not readily accessible in clinical scanners. Here we report the development of a method, SP-DQF-MT, where the four hard pulses in the DQF-MT method are replaced with two soft pulses, while preserving the same contrast. The new method was demonstrated on excised mouse brain and a rat head.

11:30 183. **Enhanced Contrast of Signal from Distant Dipolar Field on Relaxation Times and \( B_0 \) in Tissues**

Chung Ki Wong, Todd Fallesen, Patrick R. Connelly, Jianhui Zhong

1University of Rochester, Rochester, New York, USA; 2University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA; 3St. Lawrence University, Canton, New York, USA

The Bloch equation with distant dipolar field (DDF) is solved for a typical CRAZED pulse sequence with arbitrary flip angles. The \( n^{th} \) order transverse magnetization \( M_n \) at different static magnetic fields \( B_0 \) are evaluated. We compare \( M_n \) with experiments using swine muscle, and estimate signal changes for tumor versus normal tissue in mice. It is found that \( M_2 \) rises faster at large \( B_0 \) and has a higher sensitivity to the change of relaxation times than \( M_1 \). These results suggest enhanced contrast for tumor studies using distant dipolar field effects.

11:42 184. **Avalanching Amplification of MR Difference Imaging by Nonlinear Feedback Interactions at High Field**

Susie Y. Huang, Jamie D. Walls, Monty Liong, Yung-Ya Lin

1University of California, Los Angeles, Los Angeles, California, USA

The chemical exchange-dependent saturation transfer (CEST) effect provides a unique quantitative form of contrast for MR imaging. However, exchange between a target metabolite and water may not be efficient enough to produce a noticeable CEST effect. This work demonstrates how the sensitivity of MR measurements to dilute solute protons exchanging with water protons can be further amplified based on the interplay between a nonlinear feedback field (radiation damping) and RF pulses. Experiments on a simple phantom show this approach produces avalanching amplification of the CEST effect by up to 40 times in spectroscopy and 12 times in imaging.
Current understanding of SSFP signal behaviour cannot explain the oxygen-sensitive contrast observed in MR images obtained with phase-cycled balanced-SSFP sequences. In this work, we explored the mechanism responsible for the SSFP signal dependence on blood oxygen saturation and showed that the dominant mechanism responsible for the observed contrast can be attributed to motion of spins through local field inhomogeneities in and around deoxygenated red blood cells. We also studied the parameter space of the signals and the need for its optimization. Further, we demonstrated the possibility of combining Luz-Meiboom approximation with SSFP signals to obtain rapid quantitative oxygen maps.

Ongoing studies suggest that on ultra-high field MR images (≥7) the contrast is dominated by susceptibility effects not only in gradient echo but also in spin echo images. The goal of this work was to quantify mesoscopic susceptibility effects in Hahn and CPMG spin echo images. The susceptibility parameter derived from a combined fit of Hahn and CPMG images correlated with the known iron content in iron oxide samples and in tissue samples independently measured by mass spectroscopy. Initial data suggest that this approach for assessing tissue iron may be sufficiently sensitive to different Alzheimer’s from normal brain.

MRI is an increasingly important tool in iron overload disorders, but the complex nature of proton-iron interactions has troubled noninvasive iron quantification. To better understand proton relaxation mechanisms in humans, we performed NMR relaxometry on 10 fresh liver biopsy specimens from patients with transfusion dependent anemia. CPMG data were well-described by a chemical-exchange model and predicted effective iron center dimensions consistent with hemosiderin-filled lysosomes. Biexponential relaxation was evident at short refocusing intervals, but R2 and amplitude behavior was consistent with functional rather than anatomic divisions. NMR relaxometry of liver biopsy specimens yield unique insights into the mechanisms of tissue-iron relaxivity.

A constrained minimization approach to the design of multi-dimensional, spatially selective RF pulses is presented. With our approach, excitation performance with under-sampling excitation k-space trajectories can be optimized, relative excitation precision in different spatial regions can be specified, density compensation function is not needed, main field inhomogeneity can be nicely accounted for, and unrealizable RF waveforms can be avoided. Simulation results illustrate advantages of our approach over the commonly used conjugate-phase RF pulse design method.

The achievable bandwidth of RF pulses is limited by the maximum feasible B1 amplitude of the system. For reducing the B1 requirements of pulses, quadratic phase envelopes can be argued to be near optimal. In this work, it is demonstrated that further B1 reduction and hence higher bandwidths can be achieved by combining quadratic phase with higher order phase functions. Exemplary RF pulses with up to tenth order phase functions were designed using the Shinnar-Le Roux transform, yielding B1max reductions by up to 71% with respect to linear-phase design.
10:54  190. Advanced Calibration for Echo Planar 2D selective RF Pulses
Markus Oelhafen1, Klaas Paul Pruessmann1, Peter Boesiger1
1ETH and University, Zurich, Switzerland

A calibration method to suppress N/2 ghosting in 2D selective Echo Planar RF Pulses is presented. Eddy current effects leading to gradient delay and to off-resonance are compensated. In particular, gradient anisotropy, which is known to affect the magnetization profile in oblique image planes, is corrected. The method has the potential to make EPP more attractive for clinical applications such as diffusion imaging, coronary angiography and real-time flow measurement.

11:06  191. Evaluation of Broadband Decoupling Schemes for In Vivo NMR Spectroscopy
Robin A. de Graaf1, Pieter van Eijsden1, Peter Brown1, Scott McIntyre1, Terry Nixon1
1Yale University, New Haven, Connecticut, USA

Most broadband decoupling schemes have been developed for high-resolution NMR. However, the requirements for in vivo NMR are sufficiently different to demand a re-evaluation of existing broadband decoupling schemes. Simulations and experiments demonstrate that no single decoupling scheme is optimal under all conditions. WALTZ-16 and MLEV-16 perform well for RF amplitudes typically used on human brain (B1 < 0.5 kHz), while frequency-switched pulses offer a better choice for medium RF amplitudes. Adiabatic pulses typically require higher peak power (not average power), but offer a wider range of adjustable parameters to optimize an adiabatic decoupling method for a particular application.

11:18  192. SAR Reduction at 3T for Fast Spin Echo Sequence Using an Optimized VERSE Algorithm
Neville D. Gai1, Reed F. Busse2
1G. E. Medical Systems, Waukesha, Wisconsin, USA; 2G. E. Medical Systems, Menlo Park, California, USA

SAR deposition is of increasing concern at high fields especially for fast spin-echo sequences. Previously, a real-time implementation of the VERSE algorithm for single-shot fast spin-echo (SSFSE) sequence was shown to provide reduced SAR deposition with comparable or better image quality than a standard SSFSE sequence. The present study extends the algorithm to the more general fast spin-echo (FSE-XL) sequence. Optimizing the VERSE algorithm provides robust imaging across a range of FSE applications. Results prove that the modified sequence can be used in place of the standard one in a clinical environment with no operator intervention.

11:30  193. Novel Sequence for Accurate, Multi-Slice T2-Relaxometry with Insensitivity to Refocusing Pulse Profiles and Reduced SAR
Gaby Simon Pell1, Anthony B. Waites1, David Fenton Abbott1, Regula S. Briellmann1, Graeme Daniel Jackson1
1Brain Research Institute, Heidelberg West, Victoria, Australia

T2 is a sensitive indicator of conditions such as temporal lobe epilepsy and schizophrenia. Clinical acquisition typically utilises a multi-echo CMPG sequence. The method is limited by the multiple refocusing 180° pulses in the sequence. Power deposition (SAR) limits the number of slices that can be acquired. The accuracy of the T2 measurements are affected by stimulated echoes from the edges of the slice selective 180° pulses that modulate the measured T2. This report presents a novel rapid sequence for T2 relaxometry that enables accurate measurement of T2 with insensitivity to the refocusing pulse profile and with reduced SAR.

11:42  194. Actual Flip Angle Imaging in the Pulsed Steady State
Vasily L. Yarnykh1, Chun Yuan1
1University of Washington, Seattle, Washington, USA

A new method, Actual Flip Angle Imaging (AFI), has been proposed for mapping spatial distribution of radiofrequency (RF) field. AFI calculates flip-angle map from the ratio of two signals generated by a double-delayed spoiled gradient-echo sequence, which contains two identical RF pulses followed by two delays with different duration. The AFI method is very time-efficient, as it works with an effective repetition time of 100-150 ms. Applications of AFI for 3D whole-body B1 mapping and for RF correction of T1 maps obtained with a surface transmit-receive coil were demonstrated.

11:54  195. New Method of Fat and Water Signals Suppression in MRI Diagnostics of Brain Pathologies
Nikolai Anisimov1, Yuri Pirogov1, Leonid Gubskii1, Uwe Eichhoff1
1Moscow State University, Moscow, Russian Federation; 2Russian State Medical University, Moscow, Russian Federation; 3Bruker Biospin GmbH, Rheinstetten, Germany

To improve visualization of intracranial pathological forms, it is suggested to use MRI method based on simultaneous fat and water signal suppression. In this case some normal tissues are not visualized and contrast picture is maximally simplified. The purpose of the work was to study diagnostic efficiency of this method at the pathology of brain meninges and subarachnoid spaces. It is shown, that the method is useful for investigation of changes in meninges, subarachnoid spaces and other zones where pathological changes can be invisible by using standart MRI methods because of recovering pathological tissue with fat and free liquid ones.
**Tuesday AM**

12:06  **196. Velocity-Slice Selection**  
Ludovic de Rochefort¹, Emmanuel Durand¹, Xavier Maître¹, Jacques Bittoun¹  
¹CNRS - Université Paris XI, Le Kremlin-Bicêtre, France  

This work focuses on a RF/gradient series of pulses to achieve velocity-slices. It consists in a succession of hard pulses and bipolar gradients pulses encoding in a velocity direction. RF phase is variable, thus allowing velocity-slice centring. This method makes it possible to image specifically protons with a given velocity. This work shows a theoretical presentation, then an experimental validation on flowing water.

12:18  **197. Improved Uniformity of RF-Distribution in Clinical Whole Body-Imaging at 3T by Means of Dielectric Pads**  
Melanie Schmitt¹, Thorsten Feiweier¹, Wilhelm Horger¹, Gunnar Krueger¹, Lothar Schoen¹, Razvan Lazar¹, Berthold Kiefer¹  
¹Siemens Medical Solutions, Erlangen, Germany  

In recent years the trend towards higher magnetic fields has provoked the MR vendors to offer clinical MR scanners operating at 3T and higher. However, the expected gain in SNR and image quality at the higher field is often compromised by eddy-currents (signal loss) and dielectric resonance effects in the tissue. In this work we investigate the application of dielectric pads with different chemical compositions to reduce image degradation from B1-inhomogeneities in abdominal high field imaging. Our results show that pads filled with material with a high dielectric constant can significantly reduce signal loss in body imaging at 3T.

**fMRI Spatial Temporal Response**

Room D  10:30 - 12:30       Chairs: Peter Jezzard and Gary H. Glover

10:30  **198. Amplitude Correlation between Stimulus-Induced MEG and BOLD fMRI Signals**  
Renxin Chu¹, Tom Holroyd¹, Jacco A. de Zwart¹, Peter van Gelderen¹, Masaki Fukunaga¹,  
Jeff H. Duyn¹  
¹National Institutes of Health, Bethesda, Maryland, USA  

To investigate the correlation between fMRI and macroscopic electrical activity, BOLD fMRI and MEG experiments were performed on the same subjects using the same stimuli. A visual flicker stimulus of varying temporal frequency was used to elicit neuronal responses in early visual areas. A strong similarity was observed in spatial localization and frequency tuning curves between both modalities. Averaged over subjects the BOLD fMRI tuning curve was somewhat broader than MEG. Both tuning curves had a maximum at a flicker frequency of 10 Hz.

10:42  **199. High-Resolution Functional MRI of Retinotopic and Laminar Activation using a 3T Scanner**  
David Ress¹, Gary H. Glover¹, Brian A. Wandell¹  
¹Stanford University, Stanford, California, USA  

Useful fMRI volume time series were obtained on a 3T scanner with 0.375-microliter voxels. Using a small surface coil, a 10-cm field-of-view, and a 4-shot spiral readout, we obtained eight 1.5-mm-thick slices with 0.5-mm pixels every three seconds. These slices were oriented perpendicular to the calcarine sulcus, so that the measurements spanned gray matter in areas V1, V2, and V3 that represent the central 3° radius of the visual field. We used these high-resolution images to examine the retinotopic configuration tangential to cortex and the laminar response pattern through a cross-section of cortex.

10:54  **200. Tissue Specificity of fMRI Signals at Ultra-High Resolution – But Where in the Tissue?**  
Noam Harel¹, Joseph Lin¹, Yi Zhang¹, Kamil Ugurbil¹, Essa Yacoub¹  
¹University of Minnesota, Minneapolis, Minnesota, USA  

Using fMRI at high spatial resolution in a 9.4T magnet, we examined the spatial specificities of the GE-BOLD, HSE-BOLD and CBV-weighted (MION) fMRI signals to the site of neuronal activity. All three mapping signals exhibit a localized signal change at the middle cortical layers; however, largest GE-BOLD signals changes were located at the surface vessels region. In addition, following the imaging session, histological staining was done on the cortical slab corresponding to the imaged plane to identify the neuronal distribution and cortical layers borders.

11:06  **201. Cortical Layer-Dependent Basal CBV and Stimulation-Induced CBV Responses**  
Fuqiang Zhao¹, Ping Wang¹, Kamal Ugurbil¹, Seong-Gi Kim¹  
¹Brain Imaging Research Center, Pittsburgh, Pennsylvania, USA; ²Center for Magnetic Resonance Research, Minneapolis, Minnesota, USA  

To examine cortical layer-dependent basal CBV and stimulation-induced CBV responses, the cat visual stimulation model was used at 9.4T. Baseline total-CBV and microvascular-CBV were obtained by measuring R2* and R2 changes induced by 10 mg/kg MION. The highest total CBV is located at the CSF area containing large pial vessels, while the highest microvascular CBV is located at the middle of the cortex. GE and SE fMRI were obtained after the injection of MION. The maximal signal changes are occurred at the middle cortical layers, suggesting that the CBV response can be used to detect layer-dependent fMRI signal changes.
Through spatial comparison of the activation extent among ADC, perfusion and BOLD contrasts, better understanding of the signal origins of these contrast mechanisms can be reached. It was found that despite a close relationship of the signal origins between the ADC and perfusion contrasts, significant spatial discrepancies remain between their respectively activated regions. In addition, both the ADC and perfusion activations showed significant spatial discrepancies with the BOLD activation, consistent with their distinct signal origins. We anticipate that the complementary information acquired from this multi-contrast analysis can provide much better characterization of the brain hemodynamics during activation.

In this work the effect of the transit of deoxyhemoglobin through the vasculature on the temporal resolution of BOLD fMRI is investigated. To estimate the latency and width of the BOLD response, simulations of erythrocyte flow in the draining vasculature were performed, together with fMRI experiments at high spatial resolution (1.2x1.2x2.0 mm³) at 3.0 T. Results show a temporal dispersion of several seconds across pixels within the human visual cortex and indicate that, if macrovascular effects can be suppressed, the temporal resolution of BOLD fMRI can be well below the 4-7 s found in literature.

Carbon dioxide is a potent modulator of cerebral blood flow. Spontaneous fluctuations in the partial pressure of arterial and hence end-tidal carbon dioxide are associated with low frequency (0-0.05Hz) fluctuations in BOLD signal at 3 Tesla. We use such fluctuations in resting volunteers to measure the effect of the transit of deoxyhemoglobin through the vasculature on the temporal resolution of BOLD fMRI. To estimate the latency and width of the BOLD response, simulations of erythrocyte flow in the draining vasculature were performed, together with fMRI experiments at high spatial resolution (1.2x1.2x2.0 mm³) at 3.0 T. Results show a temporal dispersion of several seconds across pixels within the human visual cortex and indicate that, if macrovascular effects can be suppressed, the temporal resolution of BOLD fMRI can be well below the 4-7 s found in literature.

Resting State Networks (RSNs) represent correlations in the brain in the “resting” condition. Previous work has showed that the main frequency power is localized around 0.02Hz, thus contributing to low frequency physiological “noise”. It has also been shown how to find RSNs using a model-free approach such as ICA. Characterizing the spatial nature of RSNs is important for their interpretation. We studied a group of subjects at rest. The group analysis of RSNs was carried out using probabilistic ICA at the single-session level, followed by cross-correlation of the resulting spatial maps in order to identify patterns consistent across subjects/sessions.

We examined spatial specificity in cat primary visual cortex of deoxy-hemoglobin (deoxy-Hb) (the physiological source of blood oxygenation level dependent (BOLD) MRI), using optical imaging of light reflection changes (intrinsic signals) at 620 nm, where light absorption by deoxy-Hb is dominant. To mitigate the contribution of blood flow and volume changes to the signal, the specificity of the deoxy-Hb signal was investigated during low blood pressure. Our results suggest that the poor specificity of the signal is mainly due to draining of deoxy-Hb from the active sites rather than poor specificity of blood supply, sub-threshold activity or scattering of light.

In recent studies, the relationship between neuronal activity and the fMRI BOLD response has been probed and much of the resulting literature describes covariance of the BOLD response with changes in electrical oscillatory power, measured using both invasive and non-invasive techniques. Here, we extend these observations by elucidating spatiotemporal covariates of the BOLD response in MEG. We show, using a simple visual stimulus, that within the resolution limits of the techniques used, the BOLD response is a correlate of both electrical oscillatory changes and a sustained field response.
Evolution and Validation of Cartilage MRI in Humans

Room B-1  10:30 - 12:30      Chairs: Carl S. Winalski and Timothy J. Mosher

10:30  208.  Run while you’re young: Age Dependent Differences in Cartilage T2 Response to Running in Trained Marathoners

Timothy John Mosher1, Yi Liu1, Michael Bruce Smith1
1Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania, USA

The purpose of this study is to determine feasibility of measuring T2 changes in knee cartilage with running, and to identify differences in trained athletes as a function of age. Quantitative T2 maps of knee cartilage were obtained of 4 young and 5 older marathoners pre and post 30 minutes of running. For young marathoners an increase in T2 was observed in deep layers, while T2 shortening occurred in the superficial 50% of cartilage after running. For older marathoners, T2 shortening occurred throughout the entire thickness of weight-bearing femoral cartilage. We attribute this to increased permeability of older cartilage.

10:42  209.  Rapid Cartilage Morphology at 3.0T: Comparison of FS-SPGR, FS-SSFP, and "Dixon" SSFP Imaging

Garry E. Gold1, Scott B. Reeder1, Huanzhou Yu1, Ann S. Shimakawa2, Jane W. Johnson2, Norbert Pelc1, Christopher F. Beaulieu1, Jean H. Brittain2
1Stanford University, Stanford, California, USA; 2General Electric, Menlo Park, California, USA

Longitudinal studies of osteoarthritis require MR imaging techniques that provide rapid and accurate assessment of articular cartilage thickness and volume. In healthy volunteers at 3.0T, we compared three techniques for 3D imaging of cartilage: Fat-suppressed spoiled gradient echo (FS-SPGR); fat-suppressed steady state free precession (FS-SSFP); and Dixon SSFP. Overall cartilage SNR was higher for the two SSFP sequences despite much shorter scan times than FS-SPGR. Dixon SSFP had higher cartilage SNR and image quality scores than FS-SSFP. Of the sequences tested, Dixon SSFP provided the best combination of high image quality, fat suppression, and speed.

10:54  210.  MRI Cartilage of the Knee: Segmentation, Analysis, and Visualization.

Julio Carballido-Gamio1, Kehyang Lee1, Eugene Ozhinsky1, Sharmila Majumdar1
1University of California, San Francisco, San Francisco, California, USA

The purpose of this work was to apply and develop new techniques to segment, analyze, and visualize cartilage from MR images of the knee. The segmentation technique described in this study was semi-automatic and based on Bezier splines and a Laplacian of Gaussian filter. The analysis technique involved the calculation of 3D cartilage thickness and volume after proper shape-based interpolation based on splines has been accomplished to get quasi-isotropic voxels. Tools to visualize 3D cartilage thickness in 3D and 1D were also presented. Techniques described in this study facilitated the characterization of 3D cartilage morphology.

11:06  211.  High-Resolution Diffusion-Weighted Imaging of Cartilage Using PROPELLER

Marshall S. Sussman1, Lawrence M. White1, Timothy P. L. Roberts1
1University of Toronto, Toronto, Ontario, Canada

Previous studies have demonstrated that diffusion-weighted MRI may be useful for the detection of osteoarthritis. However, the major challenge for in vivo diffusion-weighted MR is the high spatial resolution required. Achieving submillimeter resolution with conventional diffusion-weighted imaging techniques, namely single-shot EPI (SS-EPI), is challenging due to off-resonance sensitivity and T2, T2*-induced blurring. The recently developed diffusion-weighted PROPELLER technique has the potential for overcoming these problems. The objective of this study is to compare diffusion-weighted images generated from conventional SS-EPI and PROPELLER pulse sequences. Results indicate that PROPELLER provides reduced off-resonance sensitivity and less blurring, at the cost of reduced efficiency.

11:18  212.  T2 Linear Combination Filtering in Patella Cartilage

Logi Vidarsson1, Garry Evan Gold1, John Pauly1
1Stanford University, Stanford, California, USA

Multiexponential decay in cartilage has been described in the literature. Least squares (LS) based multiexponential time series curve fitting is often employed for analysis. However the LS based method demands very high SNR, making it difficult to do LS based fits from in vivo data. Linear combination (LC) T2 filtering is a promising alternative to multiexponential T2 LS curve fitting. In this work we use three T2 filters to analyze the patella cartilage of a normal volunteers.

Peter D. Gatehouse\(^1\), Basant K. Puri\(^1\), Taigang He\(^1\), Rhidian D. Thomas\(^3\), Donald Resnick\(^4\), Graeme M. Bydder\(^4\)

\(^1\)Royal Brompton Hospital, London, UK; \(^2\)Clinical Sciences Center, London, UK; \(^3\)Imperial College, London, UK; \(^4\)UCSD, San Diego, California, USA

The objective of this study was to demonstrate the red (vascular) and white (avascular) zones of the meniscus of the knee using magnetic resonance imaging. Ultrashort echo time (UTE) pulse sequences with an initial TE of 0.08 ms and later echoes at 5.95, 11.08 and 17.70 ms were used in two normal subjects before and after intravenous administration of Gadodiamide. Difference images were formed by subtraction of later echo images from the first image. Evidence of enhancement was seen in an area consistent in location and dimensions with the red zone. Less obvious enhancement was present in the white zone.

11:42  **214. Combined T\(_1\)-T\(_2\) Mapping of Articular Cartilage at 1.5T**

Iwan Van Breuseghem\(^1\), Isabelle M.R.W. Van Mieghem\(^1\)

\(^1\)University Hospitals Leuven, Leuven, Belgium

In this study, we use a turbo-mixed MR imaging technique, which combines T1 and T2 mapping of articular cartilage in 20 healthy volunteers. We evaluate the influence of Gd-DTPA2- on T2 relaxation values of cartilage obtained with this technique and determine the range of T1 relaxation values after Gd-DTPA2- administration. T1 values range between 258 msec and 577 msec. There is no influence of Gd-DTPA2- on calculated T2 values, but correction using a linear regression model improves correlation. Combined calculations of T1 and T2 reduces problems of misregistration and can lead to a drastic reduce in scan time.

11:54  **215. dGEMRIC in Osteoarthritis: Comparison with Radiography**

Ashley Williams\(^1\), Leena Sharma\(^2\), Charles McKenzie\(^1\), Miram Afridi\(^1\), Wei Li\(^3\), Prasad Potumarthi\(^5\), Deborah Burstein\(^1\)

\(^1\)Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; \(^2\)Northeastern University, Chicago, Illinois, USA; \(^3\)Evanston Northwestern Healthcare, Evanston, Illinois, USA

dGEMRIC and radiography were compared in 11 osteoarthritis patients. dGEMRIC was in the mid to low range of values previously seen in asymptomatic individuals. Low dGEMRIC values were found in many of the “uninvolved” compartments of knees scored as K/L 3 or 4 suggesting that it is sensitive to biochemical manifestations of disease in compartments that x-ray designates as normal. Future clinical trials should enroll patients earlier in the disease process to monitor disease progression. The heterogeneity observed within and across the knees motivated implementation of 3D T1 acquisitions that were found to be comparable to the 2D acquisitions.

12:06  **216. Longitudinal Measurements of Signal Intensity as a Potential Marker for Cartilage Degeneration in Osteoarthritis**

Josephine H. Naish\(^1\), Graham Vincent\(^2\), Mike Bowes\(^2\), David White\(^3\), Manish Kothari\(^3\), John C. Waterton\(^4\), Chris J. Taylor\(^4\)

\(^1\)University of Manchester, Manchester, UK; \(^2\)Imorphics, Manchester, UK; \(^3\)Synarc Inc., San Francisco, California, USA; \(^4\)AstraZeneca, Macclesfield, UK

In this study we have developed techniques to compare local changes in signal intensity over time in fat suppressed 3D gradient echo images of articular cartilage in patients with osteoarthritis. We have applied these techniques to data taken over periods of 1 and 3 years in two groups of patients with OA and see significant changes where no significant change in total cartilage volume could be detected. We conclude that in a study of cartilage thickness this technique can provide additional information without the overhead of extra scans.

12:18  **217. Matrix-Based Autologous Chondrocyte Implantation for Cartilage Repair: Noninvasive Monitoring by High-Resolution Magnetic Resonance Imaging**

Siegfried Trattnig\(^1\), Vladimir Mlynarik, Ahmed Ba-SSalamah, Vilmos Vecsei, Stefan Marlovits

\(^1\)MR Center Vienna Medical School, Vienna, Austria

Twenty patients after matrix-based autologous chondrocyte implantation (MACI) for cartilage repair had postoperative high-resolution MRI on a standard MR scanner after 4, 12, 24, 52 weeks. A grading and point scale system was proposed for analysis of defect repair in thickness and length, integration, surface, structure of repair tissue and status of subchondral lamina and bone. Based on these grading system the calculated mean average values increased from the 4th to the 52th week in 17/20 and decreased in 3/20 patients. High resolution MRI provides an accurate noninvasive evaluation of the repair site in MACI.
It was hypothesized that brain tumor invasion is tracked using a new MRI analysis method called aDWI. Rats were inoculated with tumor cells with a fluorescent label, and stretched-exponential DWI analysis (alpha-DWI) was performed. The derived heterogeneity index a was significantly different in peritumor, tumor, normal gray matter, and normal white matter. Fluorescent cells were found in the peritumor region. No change was observed in T2-weighted and proton-density images in the peritumor region, making vasogenic edema unlikely as a source of the observed diffusion change. The heterogeneity index a is therefore thought to be a marker of brain tumor invasion.

The application of molecular biology techniques to imaging has provided unprecedented opportunities for understanding and characterizing the tumor microenvironment. The tumor microenvironment can influence cancer invasion, metastasis, and therapeutic response. Here we have combined optical, MRI and MRSI techniques to understand the relationship between vascularization, metabolism, and hypoxia. We have shown, for the first time, that hypoxic regions are characterized by increased total choline, but not lactate/lipid, and permeability.

The purpose of this study was to investigate the relationship between serum and tissue proteomic patterns in distinct tumor regions from glioblastoma multiforme (GBM) patients, as identified by gadolinium contrast enhancement patterns on T1-weighted magnetic resonance (MR) images. We found characteristic differences in the protein profile of serum from GBM patients versus normal controls. In particular, we have identified four peptides in the serum from GBM patients that are present in statistically higher concentrations than normal controls. The ability of MR imaging to identify tumor regions with increased permeability holds promise for determining the identity of these serum peptides.

The aim of this study was to evaluate the relationship between two related angiogenic processes, vascular maturation and vascular permeability. Both processes are regulated by the same molecular factors and therefore expected to be coupled. However, combined BOLD and DCE-MRI together with fluorescence microscopy revealed that correlation between the two is uncoupled. Gene expression analysis showed that tumor cells expressed VEGF while angiopoietins were expressed by infiltrating host stroma cells. These findings suggest that local gradients of these angiogenic factors could lead to heterogeneity in vascular maturation and permeability, as detected by MRI and histology.

Multiple MRI techniques have been combined to evaluate tumor microcirculation and oxygenation, and their correlation with tumor tissue oxygenation measured by 18F NMR has been compared in rat breast carcinomas. Our results suggest a close correlation between changes in tissue pO2 and BOLD response accompanying oxygen intervention. However, there was a weak correlation between baseline pO2 and BOLD response. DCE MRI data (IAUC) showed no correlation with 18F pO2 or BOLD data. Qualitative DCE and BOLD approaches provide information about tumor vascularity but do not predict quantitative pO2.
Investigation of Genetically Engineered Orthotopic Brain Tumors using Perfusion MRI Provides New Insights into the Effect of VEGF on Brain Tumor Physiology
Bradford Armstrong Moffat1, Muhammed Kariaapper1, Jadranka Stojanovska1, Kuei Lee1, Daniel Hall1, Thomas Chenevert1, Alnawaz Rehemtulla1, Brian Ross1
1University of Michigan, Ann Arbor, Michigan, USA

Genetically engineered rat glioma cells were produced to over or under express VEGF. Continuous arterial spin labeling (CASL) MRI was accomplished revealing higher blood perfusion in both tumor types as compared to wild type 9L tumors. These results give new insights into the effects of angiogenesis on tumor physiology that and have important implications for understanding the role of antiangiogenic cancer therapies.

Assessment of Contrast Perfusion, Blood Clotting, and Ulceration in Eotaxin-Secreting Tumors in Mice by T2-Weighted and Contrast Enhanced MRI
Michael Samoszuk1, Min-Ying Su1, Mark J. Hamamura1, Huali Wang1, Tom Deng2, Nicholas Asbrock1, Vivian Fong1, Thu Huynh1, Orhan Nalcioglu1
1University of California, Irvine, California, USA; 2UCLA, Los Angeles, California, USA

Eosinophils is one inflammatory cell commonly seen in the stroma of human cancers. B16 melanoma cells were transfected to secrete high levels of eotaxin to activate eosinophils. MRI was performed to characterize the tumors. Despite the much slower in-vitro growth of the eotaxin-secreting cells, the in vivo growth rate was comparable to the wild type cells. Transfectants were more likely to develop blood clot and ulceration, and had a lower perfusion, possible due to blood clot. The results suggest that eosinophils and eotaxin are more likely to mediate a wound-healing response to tumors than to mount an effective cytotoxic response.

Blood Volume Fraction (BVF) and Characteristics of Vascular Growth in VX2 Tumor Measured by MRI, Ultrasound and Micro-CT
Xiu-Ling Qi1, Xin-Wen Yu1, Juimiin Hong1, Peter Burns1, Mark Henkelman1, Graham Wright1
1Sunnybrook &Women's College HSC, Toronto, Ontario, Canada

Blood supply is necessary for tumor growth. The purpose of this study was to evaluate the relative blood volume (rBV) in a VX2 tumor at various stages of tumor development. rBV in five rabbits with VX2 tumors were measured by MRI and ultrasound. Density of blood vessels was assessed by micro-CT and 3-D MRI. rBV in the tumor rim was inversely related to the tumor size. Density of blood vessels is consistent with the rBV variation with tumor size. If this behavior holds true in human tumors, earlier administration of anti-vascular drugs may be more effective for tumor treatment.

MRI of Angiogenesis in Xenograft Tumors Using Ferumoxides Labeled Sca1+ Cells
Ali S. Arbab1, Sunil D. Pandit1, Stasia A. Anderson1, John Glod1, Martha Noel1, Amy Kable1, Gene T. Yocum1, Monica Bur1, King C. Li1, Howard A. Fine1, Joseph A. Frank1
1National Institutes of Health, Bethesda, Maryland, USA

Until recently there was no direct method to image endothelial cells into neovascularature of tumors by MRI. In this study we attempted to image angiogenesis in a subcutaneous mouse flank tumor model using ferumoxides labeled mouse Sca1+, endothelial progenitor cells (EPC). Gradient echo images showed hypointensities in the tumor and the pattern of hypointensity was different from that of control mice. Prussian blue staining showed abundant iron positive cells in the tumors having IV injected labeled Sca1+ cells. Detection of magnetically labeled EPC in implanted flank tumor vasculature was observed on in vivo and ex vivo MRI.
GOLD CORPORATE MEMBER LUNCHEON SYMPOSIUM
Amersham Health
The Great Debate II: Cardiac Controversies
Main Hall 12:30 – 13:30

CLINICAL SCIENCE FOCUS SESSION
Peripheral and Renal MR Angiography
Room A 13:30 - 15:30 Chairs: Tim Leiner and F. Scott Pereles

13:30  227. Single Injection Peripheral MRA: SNR and the Two Station Timing Bolus
Jeffrey Harold Maki1, Gregory J. Wilson2, Eubank B. William2, Kimberly M. Pederson2, Romhild M. Hoogeveen4
1University of Washington, Seattle, Washington, USA; 2Philips Medical, Bothell, Washington, USA; 3Puget Sound VAHCS, Seattle, Washington, USA; 4Philips Medical, Best, Netherlands

There is some debate as to whether a single or double injection moving table peripheral MRA is superior. Advocates of the double injection technique tout the decreased incidence of lower station venous enhancement. This study, however, finds that SNR is significantly decreased using the double injection technique, and that the vast majority of patients have no venous enhancement. Therefore, we propose a two station timing bolus technique that allows a priori prediction of venous enhancement, determining which patients require one vs. two injections, and thereby allowing the use of the higher SNR single injection technique whenever possible.

Pelin Aksit1, Vincent B. Ho2, Maureen L. Hood2, Peter L. Choyke3, Marcela B. Montequin1, Thomas KF Foo1
1GE Medical Systems, Baltimore, Maryland, USA; 2Uniformed Services University of the Health Sciences, Bethesda, Maryland, USA; 3National Institutes of Health, Bethesda, Maryland, USA

A moving-table, multi-station 2D MRA technique was developed to determine contrast bolus arrival times at the proximal and distal stations of a peripheral MRA study with a single injection. Automatic bolus detection (SmartPrep) determined the arrival time from the antecubital injection site to the abdominal aorta. Upon detection of bolus arrival, the table automatically moved to the most distal station where a multi-phase 2D acquisition was used to detect contrast arrival at the popliteal trifurcation. This method provided timing information at two locations with a single bolus and was used to optimize acquisition parameters for subsequent 3D multi-station peripheral MRA.

13:50  229. Dual-Injection Contrast-Enhanced (DICE) Peripheral MRA at 1.5T and 3.0T
1Oregon Health & Science University, Portland, Oregon, USA; 2Portland VAMC, Portland, Oregon, USA; 3Dotter Institute, Portland, Oregon, USA; 4Philips Medical Systems, Bothell, Washington, USA

Venous enhancement is a problem with typical multi-station Single-Injection Contrast-Enhanced (SICE) bolus-chase peripheral MRA. We propose a solution to this problem using a Dual-Injection Contrast-Enhanced (DICE) MRA technique. SICE and DICE MRA were compared to catheter angiography in patients with symptomatic peripheral arterial disease (PAD) using 1.5T and 3.0T MRI scanners. We found that the DICE MRA significantly increases the diagnostic accuracy for calf arteries compared to SICE technique (p<0.001), yielding a practical and reliable exam of the lower extremities at 1.5T. The DICE technique can be adapted for use at 3.0T.

14:00  230. Real-time Peripheral Magnetic Resonance Angiography: An Interactive Single-Station/Single-Injection Method
Mohammad Sabati1, M Louis Lauzon1, Nirupama Nagarajappai1, Hooman Mahallati1, Richard Frayne1
1University of Calgary, Calgary, Alberta, Canada

In continuously moving-table peripheral contrast-enhanced MR angiography, a large field-of-view (FOV) image is built up from hybrid-space data as a smaller local FOV is translated along the patient. To achieve optimal quality, the translation of the table and the data acquisition need to be synchronized with the arterial passage of the contrast agent. Recently, a 3D LFOV imaging technique was proposed that follows the passage of the contrast material in conjunction with fast hybrid-space reconstruction. Here, we present the experimental evaluation of this technique. Initial results show the feasibility of interactively following the contrast down the legs in real-time.
14:10 231. **High Spatial Resolution MR Angiography of Peripheral Vasculature-iPAT Combined with Mid-Femoral Venous Compression**  
Florian M. Vogt1, Waleed Ajaj1, Peter Hunold1, Christoph U. Herborn1, Harald H. Quick1, Jörg F. Debatin1, Stefan G. Rühm1  
1University Hospital, Essen, Germany

The study was performed to evaluate the implementation of mid-femoral venous compression combined with a parallel acquisition technique (PAT) into the concept of peripheral 3D MR-angiography. Five volunteers and five patients with occlusive arterial disease of peripheral vasculature underwent four-station contrast-enhanced 3D peripheral MRA. Acquisition time was extended with venous compression while the PAT algorithm was added to increase the spatial resolution. MRA of the peripheral arteries with a refined data acquisition technique including PAT and mid-femoral venous compression leads to vastly improved display of the peripheral vasculature including the pedal arteries. High spatial resolution is achieved without venous overlay.

14:20 232. **Decreased Venous Contamination on 3D Bolus Chase Peripheral MRA with Thigh Compression**  
Honglei Zhang1, Bernard Ho1, Minh Chao1, K. Craig Kent1, Harry L. Bush1, Peter L. Faries1, Alan I. Benvenisty2, Martin R. Prince1  
1Weill Medical College of Cornell University, New York, USA; 2Columbia College of Physicians and Surgeons, New York, USA

Bilateral calf arterial flow and tissue enhancement measurements with a blood pressure cuff on one leg were performed with time-resolved MRA to determine the effect of thigh compression. Compared to the leg without compression, 60 mmHg inflation pressure delayed contrast arrival time to the trifurcation by only 4.7 ±2.2 seconds but there was sustained suppression of tissue enhancement (> 40 seconds). This improved 3D bolus chase peripheral MRA allowing longer imaging times for higher resolution while eliminating venous contamination in the calves.

14:30 233. **A Dual-Velocity Acquisition Method for Continuously-Moving-Table Contrast-Enhanced MRA**  
David G. Kruger1, Ananth J. Madhuranthakam1, Houchon H. Hu1, Jason A. Polzin2, James F. Glockner1, Stephen J. Riederer1  
1Mayo Clinic, Rochester, Minnesota, USA; 2GE Medical Systems, Milwaukee, Wisconsin, USA

The spatially variable velocity of the contrast bolus in the proximal vs. distal peripheral vasculature makes it challenging for a single-velocity continuously moving table acquisition to track the contrast bolus over the extended FOV. To address this we have developed a dual table velocity method that is able to slow the patient table when the sensitive moving FOV reaches the knees. An additional benefit is that once the table slows it is possible to encode significantly higher spatial frequencies. Results in 15 volunteers show consistently improved contrast in the lower legs as well as improved resolution.

14:40 234. **“Shoot and Scoot” Lower Extremities MR Angiography: First Clinical Trial**  
Patrice Hervo1, Valerie Laurent2, Lionel Meyer-Bisch2, Pelin Aksit1, Vincent Ho1, Marcella Montequin1, Thomas Foo3, Denis Regent2  
1GE Medical Systems, Buc, France; 2University Hospital of Nancy, Nancy, France; 3GE Medical Systems, Baltimore, Maryland, USA; 4Uniformed Services University of the Health Sciences, Bethesda, Maryland, USA

We studied the ability of the technique called “Shoot and Scoot” (S&S) [1], based on a segmented volume acquisition, to reduce the occurrence of venous return and to improve the spatial resolution of all the stations of the MR Angiography of the lower extremities. We compared two different types of k-space view ordering for the aorto-iliac and femoral stations: elliptic centric and centric. S&S appeared as an excellent technique to acquire the data of the third station sooner, therefore minimizing the percentage of impairing venous return, while improving the spatial resolution of the most proximal and distal stations.

14:50 235. **High-Resolution MRA of the Renal Arteries using Parallel Acquisition Techniques: Value of Isotropic Cross-Sectional Reformats Compared to Digital Subtraction Angiography and Intravascular Ultrasound**  
Stefan O. Schoenberg1, Johannes Rieger1, Christoph Weber3, Henrik J. Michaely1, Tobias Waggershauser2, Mathias Nitka2, Maximilian F. Reiser1  
1University Hospitals, Ludwig-Maximilians-Universitaet, Munich, Bavaria, Germany; 2Siemens Medical Solutions, Erlangen, Bavaria, Germany

Due to the eccentricity of atherosclerotic disease, measurements of renal artery stenosis on 3D contrast-enhanced MR-angiography is often inaccurate. The recently introduced intravascular ultrasound (IVUS) technique is considered the gold standard method to determine the true vessel area stenosis. High-resolution 3D-Gd-MRA with isotropic sub-millimeter voxel size using parallel acquisition techniques now also allows to reconstruct cross-sectional cuts for measurements of vessel area stenosis. The use of these cross-sectional cuts significantly increases diagnostic accuracy compared to DSA and IVUS and decreases interobserver variability. Discrepancies in stenosis grading are reduced from 39% to only 12%.
15:00  **236. Comparison of Catheter-Based Intraarterial Gadolinium-Enhanced MR Angiography with Cross-Sectional TrueFISP for the Detection of Renal Artery Stenosis**  
Reed A. Omary¹, Brian E. Schirf¹, Jordin D. Green¹, Richard Tang¹, Kent Sato¹, Ali Shaibani¹, James Carr¹, Debiao Li¹  
¹Northwestern University, Chicago, Illinois, USA

In a swine model of renal artery stenosis, we compared the diagnostic accuracy of catheter-based intraarterial (IA) injections of gadolinium-chelates (Gd) using 3D fast low angle shot (FLASH) MR imaging, with and without inversion recovery (IR), to cross sectional 2D true fast imaging with steady-state precession (TrueFISP) without contrast agent. X-ray digital subtraction angiography (DSA) was employed as the reference standard. Using linear regression, TrueFISP differed significantly from 3D IA-FLASH methods (p <0.05). Cross sectional TrueFISP improves the accuracy of renal artery stenosis detection over 3D IA-FLASH methods alone.

15:10  **237. Renal MR Angiography with Steady-State Free-Precession (SSFP) and Slice-Selective Spin Inversion during Free Breathing**  
Marcus Katoh¹, Arno Buecker¹, Matthias Stuber², Rolf W. Guntner¹, Elmar Spuentrup¹  
¹RWTH Aachen University Hospital, Aachen, Germany; ²Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

The aim of our study was to investigate a 3D steady-state-free-precession (SSFP) sequence for free-breathing renal MR angiography (MRA) without contrast medium and to examine the advantage of an additional inversion prepulse for improved contrast. A navigator-gated cardiac-triggered 3D SSFP sequence was performed either without magnetization preparation or with a non-slice-selective inversion pulse or a slice-selective inversion pulse in eight volunteers and eight patients. Images were analyzed concerning SNR and CNR. SSFP imaging combined with a slice-selective inversion pulse allows for selective and high-contrast visualization of the renal arteries without the need for contrast media application.

15:20  **238. Steady State Free Precession MRA of the Renal Arteries: Breath-hold and Navigator Techniques vs. CE-MRA**  
Jeffrey Harold Mak¹, Gregory J. Wilson², Kimberly M. Pederson¹, Eubank B. William¹, Sudhaker Pipavath¹, Romhild M. Hoogeveen¹  
¹University of Washington, Seattle, Washington, USA; ²Philips Medical, Bothell, Washington, USA; ³Puget Sound VAHCS, Seattle, Washington, USA; ⁴Philips Medical, Best, Netherlands

While bright blood Steady State Free Precession (SSFP) techniques have revolutionized cardiac MRI, they also are becoming increasingly useful for MR angiography. We test the hypothesis that SSFP is a useful rapid screening technique for renal artery stenosis, determining which patients need to go on to have a standard contrast enhanced MRA. Three SSFP sequences, 2 breath-hold and 1 free-breathing navigator, were evaluated and compared to 3D contrast enhanced MRA. Navigator free-breathing SSFP performed best, appearing to be a reliable indicator of renal vascular disease.

**CLINICAL SCIENCE FOCUS SESSION**  
MR Mammography: Clinical and Technical Developments

Room B-2  13:30 - 15:30  Chairs: Christiane K. Kuhl and Francesco Sardanelli

13:30  **239. Correlation of Magnetic Resonance Enhancement Morphology and Breast Density Patterns for Ductal Carcinoma In Situ.**  
Catherine Klifa¹, Jessica Gibbs¹, Shelley Hwang¹, Nola Hylton¹  
¹University of California San Francisco, San Francisco, California, USA

In this study we explored the relationship between the Magnetic Resonance (MR) enhancement patterns of Ductal Carcinoma In Situ (DCIS) lesions and the surrounding breast tissue morphology qualitatively assessed from pre-contrast MR data, in order to (1) study the occurrence of typical DCIS enhancement patterns in different breast density types (2) better understand DCIS potential to progress to invasive breast cancer. In this preliminary investigation, we classified morphological patterns of enhancement (linear, granular, segmental, focal) and MR breast density types (1 very dense to 4 very fatty breast tissue) in a group of 47 DCIS patients.

13:40  **240. Neoadjuvant Chemotherapeutic Response of Breast Cancer: Evaluation by High Spatial Resolution MRI with Adjusted 3-Time Point Method**  
Chen-Pin Chou¹, Ming-Ting Wu¹, Edna Furman-Haran², Hong-Tai Chang¹, Hadassa Degani², Huay-Ben Pan¹  
¹Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan; ²The Weizmann Institute of Science, Rehovot, Israel

The response of locally advanced breast cancer (n=15) before and after neoadjuvant chemotherapy was investigated using three time point MRI and pathomorphological correlation. Dynamic contrast enhancement was measured using high spatial resolution 3DSPGR with adjusted 3 time point (3TP) model. The correlation between tumor diameter measured by histopathology was 0.88 (P<0.001). 3TP T MRI appears to provide precise residual tumor size and monitors functional change in tumor angiogenesis.
13:50 241. Predicting Response to Neoadjuvant Chemotherapy using Textural Analysis  
Peter Gibbs¹, David J. Manton¹, Martin Lowry¹, Lindsay W. Turnbull¹  
¹University of Hull, Hull, UK

Textural analysis of high-resolution post-contrast images of the breast has been performed. Images were acquired before, during, and after neoadjuvant chemotherapy. Significant differences in texture were noted, between poor and good responders, on images obtained prior to the commencement of treatment, indicating textural analysis may have a role in predicting response.

14:00 242. What is the Clinical Impact of Breast MRI?  
Sasha I. Usiskin¹, Michael Douek², Neill Patani², Margaret A. Hall-Craggs¹  
¹University College London Hospitals NHS Trust, London, UK; ²Royal Free and University College Medical School, London, UK

We evaluated the clinical impact of breast MRI on patient management and outcome. Data on clinical indication as well as scan reports were collected prospectively over a 2 year period. An independent radiologist and breast surgeon jointly reviewed each patient data set and undertook correlation with clinical and pathological data. Breast MRI was found to have a positive impact, contributing to appropriate patient management and decision-making, particularly in breast cancer patients with suspected recurrence or in those undergoing MRI follow-up. The detection of additional indeterminate lesions however, could lead to a negative clinical impact.

14:10 243. Dynamic Breast MR Imaging at 3.0T: Intra-Individual Comparative Study Compared to 1.5T  
Christiane K. Kuhl¹, Juergen Gieseke¹, Nuschin Morakkabati¹, Renate Blömer², Claudia Leutner¹, Christiane Sonntag¹, Hans H. Schidl¹  
¹University of Bonn, Bonn, Germany

A prospective intra-individual comparative study was performed on 24 patients with a total 30 contrast enhancing lesions who underwent breast MRI both, on a 1.5T and a 3.0T system. At both systems, dynamic bilateral subtracted contrast enhanced MR mammography was performed with equivalent geometric parameters; at 3.0T, SENSE was used. In addition, ultra-high-resolution pulse sequences were acquired at 3.0T. Detectability of lesions, morphologic features and enhancement patterns were compared. All lesions were identified on both systems. Lesion enhancement rates and time course kinetics were equivalent. The ultra-high-resolution studies at 3.0T allowed the assessment of morphologic lesion features with unprecedented detail.

14:20 244. Successful Application of High Spatial and Spectral Resolution MR for Imaging of Small Breast Lesions  
Milica Medved¹, Gillian Newstead¹, Peter M. MacEneaney¹, Weiliang Du¹, Marta A. Zamora¹, Xiaobing Fan¹, Olufunmilayo I. Olopade¹, Gregory S. Karczmar¹  
¹University of Chicago, Chicago, Illinois, USA

The efficacy of high spatial and spectral resolution (HiSS) MR imaging in clinical practice is successfully tested on 22 patients with mammographically suspect lesions. Fifteen lesions were smaller than 25 mm. Fat-suppressed images obtained using HiSS are compared to standard clinical fat-saturated images. Fat suppression in HiSS-generated images is more robust than and superior to that obtained by standard clinical sequence, yielding better lesion delineation and conspicuity. In addition, HiSS images show a larger dynamic range and better contrast within the lesion. These advantages of HiSS images may lead to improved specificity of breast MR through better lesion characterization.

14:30 245. Vacuum-Assisted iMRI-Guided Percutaneous Core Biopsy of Small Breast Lesions: First Experience with a Vertically Open 0.5T Scanner in the Prone or Supine Position  
Gloria L. Hwang¹, Debra M. Ikeda¹, Robyn L. Birdwell¹, Bruce L. Daniel¹  
¹Stanford University Medical Center, Stanford, California, USA

We describe a novel method of vacuum-assisted core biopsy in a 0.5T open MR using a freehand approach. The patients can be positioned prone, allowing medial or lateral access to lesions, or supine, allowing an anterior approach. Biopsies of 17 lesions in 14 patients have yielded one malignant diagnosis. No discordant diagnoses were found in five patients who underwent surgical excision of the lesion sites. This method provides a minimally invasive alternative for sampling suspicious lesions detected on MRI. It allows a three-dimensional approach to targeting lesions and allows sampling of multiple or difficult-to-access lesions.

14:40 246. Monitoring Primary Systemic Therapy in Locally Advanced Breast Cancer using Proton and Sodium Magnetic Resonance Imaging  
Michael A. Jacobs¹, Ronald Ouwerkerk², Antonio C. Wolff¹, Vered Stearns¹, Paul A. Bottomley¹, David A. Bluemke¹, Zaver Bhujwalla¹  
¹Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Combined clinical proton imaging and sodium (23Na) imaging for the monitoring of chemotherapy intervention in locally advanced breast cancer are reported for the first time in clinical patients. We demonstrate that both proton and sodium MR additional metabolic information that may assist in the monitoring of breast cancer.
Adaptive reconstruction allows the formation of both low and high spatial resolution images from a single data set. In this work, we demonstrate an application of this technique to bilateral breast imaging using PR-TRICKS. Low resolution images have 12 slices per breast, with a temporal resolution of 12 seconds. High resolution images have 36 images per breast and are obtained in 192 seconds.

The pharmacokinetic analysis of contrast reagent (CR) bolus-tracking (B-T) data can be corrected for the variation of the MR shutter-speed for equilibrium transcytolemmal water exchange. When this is done, there is an increase in the values of the two parameters obtained with the standard model, as well as an increase in parameter dimensionality. These provide improved discrimination of the benign fibroadenoma and malignant invasive ductal carcinoma breast pathologies.

The 3D PR-TRICKS was modified and applied to dynamic contrast-enhanced MRI of Breast. The ability to obtain high spatial resolution with moderate temporal resolution facilitates improved depiction and dynamics of contrast uptake in tumors.

Magnetic resonance diffusion imaging (MRDI) was used to assess quantitatively three diffusion rates in tissue. For the first time, a rat breast tumour model was used to produce maps of slow and intermediate diffusion rates of water in tumour tissue, pseudo-diffusive microvascular flow, and fractional volumes of tumour contributing to each diffusion rate. Structures in the slow and intermediate diffusion parameter maps correlated to structures in high resolution images, and the density and distribution of microvasculature in the high diffusion rate maps correlated to micro-CT images of the vasculature. Structures and microvascular distributions are known to be diagnostic and prognostic.
Tuesday PM

BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)
Design Considerations for RF Coils in Parallel Imaging

Sakura 13:30 – 15:30 Chairs: Michael B. Smith and Joseph V. Hajnal

Please see page for details.

BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)
MSK Gone Soft: MR Imaging of Cartilage and Muscle

Room B-1 13:30 – 15:30 Chairs: Miika T. Nieminen and Garry E. Gold

Please see page for details.

Cells: Inside and Out?

Main Hall 16:00 - 18:00 Chairs: Christopher A. Clark and Alex L. Mackay

16:00 251. Young Investigator Awards Finalist: A New Modeling and Experimental Framework to Characterize Hindered and Restricted Water Diffusion in Brain White Matter
Yaniv Assaf1, Raisa Z. Freidlin2, Gustavo K. Rohde2, Peter J. Basser2
1Tel Aviv Sourasky Medical Center, Tel Aviv, Israel; 2National Institutes of Health, Bethesda, Maryland, USA

White matter is composed of ordered fascicles whose axons are surrounded by a complex extra-axonal environment containing astrocytes, glia and extracellular matrix. It is suggested that the diffusion-weighted signal at low and high-b-values may probe different water pools. Recently, a model of water diffusion in white matter was proposed that contains a hindered extra-axonal compartment, whose diffusion properties are characterized by an effective diffusion tensor, and an intra-axonal compartment, whose diffusion properties are characterized by a restricted model of diffusion within cylinders. Here, we have used this model to fit experimental data collected from areas of crossing white matter fibers.

16:20 252. Characterization of Intravoxel Diffusion from HARD MRI
Yunmei Chen1, Weihong Guo1, Qingguo Zeng1, Guojun Alex He1, Yijun Liu1
1University of Florida, Gainesville, Florida, USA

A variational model was proposed to determine intra-voxel fiber orientations under the assumption of bi-Gaussian diffusion. The voxel classification is based on spherical harmonic representation of the apparent diffusion coefficient profiles from high angular resolution diffusion-weighted MRI data. Our approach is to simultaneously estimate and regularize two tensor fields representing the diffusion density function and the field of proportionality corresponding to the mixed Gaussians. For increasing accuracy of the estimation, we incorporated the location information of voxels with strong isotropic or single-fiber diffusion into their energy functionals. Our results indicate that the model is effective in recovering intra-voxel multifiber diffusions.

16:32 253. Water Diffusion in Perfused Human Glioma Cells
Jean-Philippe Galons1, Silvia Lope-Piedrafita1, Joseph L. Divijak1, Robert J. Gillies1, Theodore P. Trouard1
1University of Arizona, Tucson, Arizona, USA

The attractiveness of diffusion-weighted magnetic resonance spectroscopy (DWMRS) in monitoring chemotherapeutic response in tumors resides in its ability to detect local microstructural changes long before their effects are translated into effective size changes. However, interpreting the changes in the measured apparent diffusivities and their volume fractions in terms of morphologic and physiologic parameters remains a challenge. In this study we use a hollow fiber bioreactor system to characterize water diffusion in a human glioma cell line (U251) under a stable and controlled environment. The effects of restriction, compartmental exchange and relaxation on parameters measured with DWMRS are discussed.

16:44 254. The Influence of Membrane Permeability on Bi-Exponential Behavior of Diffusion-Attenuated MR Signal from a Single Cell
Alexander L. Sukstanskii1, Joseph J.H. Ackerman1, Dmitriy A. Yablonskiy1
1Washington University, St. Louis, Missouri, USA

A bi-exponential diffusion-attenuated MR signal behavior in compartments with impermeable boundaries has been analyzed previously. It was shown that for short diffusion time, the signal dependence on the b-value can be approximated to a remarkable degree by the bi-exponential function. The influence of a finite permeability of the boundaries is a subject of the present communication. Analytical expressions for a magnetization distribution and for the net signal are found and analyzed. We conclude that bi-exponential signal behavior predicted for a single cell with impermeable membranes still holds in the presence of finite membrane permeability in the physiological range.
16:56  255.  Estimations of Membrane Permeability and the Intracellular Diffusion Coefficient Based on the Pulsed-Gradient Spin-Echo Measurement and the Finite Difference Diffusion Simulation

Masato Sano¹, Masaki Sekino¹, Mari Ogiue-Ikeda¹, Shoogo Ueno¹
¹Graduate School of Medicine, University of Tokyo, Tokyo, Japan

We propose a method of estimating the membrane permeability and the intracellular diffusion coefficient using the pulsed-gradient spin-echo measurement in combination with numerical simulation. Diffusion signal attenuation of leukocytes was measured with b factors up to 6000 s mm⁻¹. For numerical simulations, the cell was modeled as a 15 x 15 µm² square with various membrane permeabilities and intracellular diffusion coefficients. By minimizing the difference in signal attenuations between the measurement and the simulation, the membrane permeability and the intracellular diffusion coefficient were estimated as 2.8 µm s⁻¹ and 7.3 x 10⁻⁸ mm s⁻¹, respectively.

17:08  256.  Characterization of Water Diffusion in Gray and White Matter using the Inverse Laplace Transform

Itamar Ronen¹, Steen Moeller¹, Kamil Ugurbil¹, Dae-Shik Kim²
¹University of Minnesota, Minneapolis, Minnesota, USA; ²Boston University, Boston, Massachusetts, USA

In order to gain insight into diffusion processes in the brain, we investigated the distribution of water diffusion coefficients in cat brain at 9.4T by means of the optimized Inverse Laplace Transform. The results are then compared to those obtained with a biexponential fit on the same data. The resulting “diffusograms” indicate a stable bimodal distribution of ADCs, where most of the distribution lies around 0.2x10⁻³ and 1x10⁻³. There is only partial agreement with the results of the biexponential analysis, and no agreement in gray matter and in white matter when the gradients are applied parallel to the fiber direction.

17:20  257.  Mapping Human Cerebral Water Compartments Based on Simultaneously Acquired T₁ and T₂ Data – Evidence of Dysmyelination in Phenylketonuria

Peter Vermathen¹, Joachim Pietz¹, Chris Boesch¹, Roland Kreis¹
¹University & Inselspital, Berne, Switzerland; ²University of Heidelberg, Heidelberg, Germany

Relaxometry based on an inversion-recovery multiple-echo sequence was used to characterize and map four brain compartments: tissue water in gray (GM) and white matter (WM), CSF, and water in myelin layers. The method was tested on volunteers and patients with phenylketonuria (PKU). The method appears robust and suitable to characterize focal or diffuse cerebral abnormalities. Myelin water distribution correlated with WM distribution, confirming previous results. An average myelin component of 14.2±2.4% (relative to WM) was found. PKU subjects had a significantly lower myelin component of 10.8±1.5%. This result confirms the concept of dysmyelination as cause of MRI abnormalities in PKU.

17:32  258.  Measurement of Glutamate ADC in the Monkey Brain using an Optimized Diffusion-Weighted STEAM Sequence at 3T

Julien Valette¹, Laurent Besret¹, Fawzi Boumezbeur¹, Phillipe Hantraï², Gilles Bloch¹, Vincent Lebon¹
¹CEA-SHFI, Orsay, France; ²URA CEA-CNRS 2210, Orsay, France

A diffusion-weighted STEAM sequence was designed in order to measure the apparent diffusion coefficient of glutamate in the monkey brain on a whole-body 3 Tesla system. TE and TM were adjusted for maximizing glutamate signal intensity. The optimized STEAM sequence was used on 2 macaque monkeys to measure glutamate ADC in a 3.9mL voxel centered around the striatum, leading to ADC≈µm²/ms.

17:44  259.  Combining DWI with MT - Towards Compartment-Specific Diffusion Measurements

Itamar Ronen¹, Kamil Ugurbil², Dae-Shik Kim²
¹University of Minnesota, Minneapolis, Minnesota, USA; ²Boston University, Boston, Massachusetts, USA

Water diffusion in cat brain was investigated combining multidirectional diffusion-weighted images using multiple b-values, together with magnetization transfer contrast. The MTC attenuates signal originating from water molecules that rapidly exchange with binding sites on large macromolecules, and in brain white matter it is assumed that a significant portion of the MTC is due to the interaction of water with the extra-axonal myelin sheath. Henceforth, multieponential analysis of diffusion curves with and without MTC may shed light on the contribution of the extra-axonal water to the diffusion signal, and on the relationship between diffusion components and tissue compartments in the brain.

MR PHYSICS AND TECHNIQUES FOR CLINICIANS

Room A  16:00 – 18:00 Chairs: Frank R. Korosec and Joseph C. McGowan

Educational Objectives

Upon completion of this course, participants should be able to:
• Define and describe the fundamental principles of MR imaging, including the definition of spin magnetization, the Larmor relationship, relaxation phenomena, and the process of using the spin magnetization to produce an image;
• Explain imaging pulse sequences based upon spin and gradient echoes, including fast spin echo and echo planar techniques;
• Design MR imaging protocols for diagnostic applications considering image contrast, spatial resolution, acquisition time, signal-to-noise ratio, and artifacts;
• Describe the principles and capabilities of various advanced MR techniques, including diffusion, cardiac and functional MRI and spectroscopy.

16:00  **Spin Echo Imaging**  
*Bruce Pike*

16:40  **Gradient Echo Imaging**  
*Michael Markl*

17:20  **Fast Spin Echo Imaging**  
*Joseph C. McGowan*

18:00  **Adjournment**

**Rapid Steady State Free Precession Imaging**

Annex 1  16:00 - 18:00  **Chairs: Klaus Scheffler and Elliot R. McVeigh**

16:00  **260. Time-Optimal VERSE Excitation for 3D Balanced SSFP Imaging**  
*Brian Andrew Hargreaves*, *Charles Henry Cunningham*, *Dwight George Nishimura*, *Steven Michael Conolly*  
1Stanford University, Stanford, California, USA

Balanced steady-state free precession (SSFP) imaging sequences require short repetition times to avoid off-resonance artifacts. The use of slab-selective excitations is common, as this can improve imaging speed by limiting the field-of-view. However, the necessarily short-duration excitations have poor slab profiles. This results in unusable slices at the slab edge due to significant flip angle variations or aliasing in the slab direction. Using variable-rate selective excitation (VERSE), it is possible to design short pulses with dramatically improved slab profiles. These pulses achieve high flip angles with only minor off-resonance sensitivity, while meeting SAR limits at 1.5 T.

16:12  **261. Optimized Canonical Sampling Patterns in k-t Space with Two and Three Spatial Dimensions for k-t BLAST and k-t SENSE**  
*Jeffrey Tsao*, *Sebastian Kozerke*, *Michael S. Hansen*, *Peter Boesiger*, *Klaas P. Pruessmann*  
1Swiss Federal Institute of Technology, Zurich, Switzerland; 2University of Aarhus, Aarhus, Denmark

$k$-$t$ BLAST and $k$-$t$ SENSE improve the efficiency of data acquisition in dynamic imaging by packing the image signals more tightly in $x$-$f$ space ($x$=spatial position, $f$=temporal frequency). This packing is determined by the $k$-$t$ sampling pattern, which can be optimized to minimize signal overlap in order to improve reconstruction quality. However, the number of possible sampling patterns is astronomical. In this work, we describe a criterion and an efficient approach to finding sampling patterns that will be generally optimal for typical image series. The improvement of using such optimized patterns is demonstrated with *in vivo* cardiac images.

16:24  **262. Correction for Concomitant Gradient Field Effects in Refocused SSFP**  
*Christopher Thomas Sica*, *Craig H. Meyer*  
1University of Virginia, Charlottesville, Virginia, USA

The effects of concomitant gradients on refocused SSFP scans was explored to determine the extent of the artifacts produced. It was found for a typical TrueFISP sequence that concomitant gradients cause nulling of the image signal in a band roughly 13 cm from isocenter in $z$. A correction method for transverse scans, and a different method for sagittal/ coronal scans was utilized and found to provide good artifact correction. High resolution or offset scans are especially susceptible to this banding artifact.

16:36  **263. Single Acquisition Water Fat Separation for SSFP Cardiac CINE Imaging: Feasibility Study**  
*Huanzhou Yu*, *Scott B. Reeder*, *Michael Markl*, *Norbert J. Pelc*  
1Stanford University, Stanford, California, USA

Among the developed water-fat separation techniques, it is difficult to achieve a good balance between reliable fat-suppression and short acquisition times. We propose a single acquisition water-fat separation method for dynamic imaging that is able to correct for the field inhomogeneity like the 3-pt Dixon technique, while keeping the scan time comparable to non-Dixon imaging by using pre-acquired field and phase information. The feasibility of the method is illustrated for cardiac SSFP CINE imaging and provides uniform water-fat separation. The method has potential applications in real-time dynamic imaging to help decrease the scan time or increase temporal resolution.
16:48  264.  Fat Suppression in Single Acquisition Steady-State Free Precession Using Multiple Echo Radial Trajectories
Aiming Lu1, Howard A. Rowley1, Thomas M. Grist1, Walter F. Block1
1University of Wisconsin-Madison, Madison, Wisconsin, USA

The off-resonant phase accrual within each excitation in steady-state free precession (SSFP) is exploited to separate fat and water in a single acquisition. Phase accrual at different echo times is measured with a multiple echo radial trajectory. Linear combinations of these echoes create wide passbands and stopbands with increased robustness to B0 inhomogeneity. Further removal of the undesired signal can be achieved by exploiting the phase response of the combined signal. Angiography and musculoskeletal applications with 50% scan time reductions from previous work are demonstrated.

17:00  265.  A Short-train SSFP Sequence with Intrinsic Fat Suppression
J. Andrew Derbyshire1, Daniel A. Herzka1, Elliot R. McVeigh1
1National Institutes of Health, Bethesda, Maryland, USA

A method is presented that exploits the inherent spectral selectivity of the SSFP pulse sequence underpinning FISP to provide suppression of one spectral component. The method is shown to be able to provide significant attenuation of fat signals during FISP imaging at 1.5T, while the water signals are essentially unaffected and provide the normal SSFP contrast. Fat suppression is achieved with relatively little temporal overhead (approximately 1-2 TRs reduction in temporal resolution).

17:12  266.  Fast Fat Saturation for Balanced SSFP Imaging at Low Flip Angles using Alternating TR
Jochen Leupold1, Klaus Scheffler1, Juergen Hennig1
1Universitaetsklinik Freiburg, Freiburg, Germany; 2Universitaetsklinik Basel, Basel, Switzerland

A new technique is presented to acquire balanced SSFP images with supressed fat signal. This is achieved by alternating repetition times and a specific 0 -90 -180 -270 pulse phase pattern. The response function for off-resonance frequencies is modified and shows a stopband for the fat frequency regime. On-resonance steady state signal is enhanced at low flip angles, thereby lowering SAR without loss in S/N ratio. The method is useful for all b-SSFP applications which require fat saturation, e.g. for coronary artery imaging.

17:24  267.  Parallel Cardiac CINE Imaging: Application to “Dixon” Water-Fat Separation and Steady-State Free Precession
Scott B. Reeder1, Charles A. McKenzie2, Michael Markl1, Huanzhou Yu1, Norbert J. Pelc1, Jean H. Brittain1
1Stanford University, Stanford, California, USA; 2Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Massachusetts, USA; 3GE Medical Systems, Menlo Park, California, USA

This work describes the combination of parallel imaging and cardiac CINE imaging for use with steady-state free precession and “Dixon” water-fat separation, in order to achieve reliable fat suppression for breath-held cardiac SSFP CINE imaging. Multi-coil data sets under-sampled in the phase-encoding direction were acquired at three short TE increments, and reconstructed with a parallel imaging algorithm. An iterative least-squares method decomposed the unwrapped images into separate water and fat images. Using a four-element torso phased array coil, high quality images with uniform water-fat separation were acquired in approximately one half the breath-hold time.

17:36  268.  Phase Cycled Steady State Free Precession with Multipoint Fat-Water Separation
Ken-Pin Hwang1, Heidi A. Ward1, Jason A. Polzin1, Jingfei Ma2
1General Electric Medical Systems, Waukesha, Wisconsin, USA; 2U.T. M. D. Anderson Cancer Center, Houston, Texas, USA

Techniques for fat-water separation with steady state free precession (SSFP) imaging places strict demands on hardware and field homogeneity. While the more robust multipoint method for distinguishing water and fat will extend TR, it is fully compatible implementing a phase cycling scheme for reducing areas of signal loss. Using such a sequence with three echoes per TR, sufficient quality phase evolution maps were created to perform fat-water separation in a phantom and in the head and extremities of volunteers. The range of information from both phase cycling and multipoint acquisitions is made available for artifact reduction algorithms.

17:48  269.  Lipid Elimination with an Echo-Shifting N/2-Ghost Acquisition (LEENA)
Chris A. Flask1, Jonathan S. Levin1, Jeffrey L. Deerk1
1Case Western Reserve University and University Hospitals of Cleveland, Cleveland, Ohio, USA

Lipid Elimination with an Echo-shifting N/2-Ghost Acquisition (LEENA) is a new, rapid fat suppression technique using echo time alternation in the phase encode direction to cause ghosting of only off-resonance (fat) spins. Separate and uniform water and fat images were reconstructed from ghost cancellation and off-resonance correction algorithms using apriori knowledge of multiple coil sensitivities. This method improves upon the multi-point Dixon methods by providing equivalent fat suppression and spatial resolution in a single acquisition.
fMRI: Spatial and Temporal Signal Characteristics

16:00 270. **Cortical Depth-Related Functional $R_2$ and $R_2^*$ Changes at 9.4 T**

Fuqiang Zhao, Ping Wang, Seong-Gi Kim
1Brain Imaging Research Center, Pittsburgh, Pennsylvania, USA

To examine cortical depth-related signal changes of gradient-echo (GE) and spin-echo (SE) blood oxygenation level dependent (BOLD) fMRI signals, a well-established cat visual stimulation model was used at 9.4T. The stimulation-induced $DR_2^* (= DR_2^* - DR_2$ ) is closely related with the basal susceptibility effects. The ratio of $DR_2^*$ to $DR_2$ is also closely related to basal susceptibility effects. The averaged ratio of $DR_2^*$ to $DR_2$ is $8.8 \pm 1.7$ ($n = 4$) on the surface of the cortex with large pial draining vessels and decreases to $1.9 \pm 0.1$ on the middle cortical areas with parenchymal microvessels.

16:12 271. **Elevated Cerebral Energy Use Without Vascular Response**

Hanzhang Lu, Xavier Golay, James J. Pekar, Peter C. van Zijl
1Johns Hopkins University, Baltimore, Maryland, USA

It is generally assumed that the hyperemia during brain activation is a direct response to the energy demands of activation. Here we report experimental evidence that activation-based increases in oxygen metabolism can occur without increases in flow. When studying visual activation in humans, we observed a post-activation period of ~30 seconds during which oxygen consumption was still elevated, while CBF and CBV had already returned to baseline levels. Such a prolonged and complete dissociation of vascular response and energy metabolism during the post-stimulus period strongly indicates that the flow increase during brain activation is not directly caused by metabolic demands.

16:24 272. **Estimating Dynamic CMRO$_2$ from Dynamic CBF and BOLD fMRI Measurements**

Paul K. Maciejewski, Ikuhiro Kida, Fahmeed Hyder
1Yale University, New Haven, Connecticut, USA

A model for oxygen transport from blood to tissue is used to estimate dynamic changes in CMRO$_2$ in rat brain during functional activation on the basis of dynamic measurements of CBF and BOLD signal obtained using MRI techniques. The model makes a clear distinction between oxygen transport from blood to tissue and oxygen consumption within the tissue, and does not equate the two. The model can also be used to estimate oxygen concentration in blood and tissue during functional activation.

16:36 273. **A Hypothesis for Cerebral Blood Flow Regulation and the Origin of the BOLD Effect**

Richard Bruce Buxton
1University of California, San Diego, La Jolla, California, USA

The function served by CBF regulation is poorly understood, particularly the reduction of oxygen extraction fraction with increased neural activity that underlies the BOLD effect and the strong response to inspired CO$_2$. Calculations of the transport kinetics of O$_2$ and CO$_2$ between blood and mitochondria in the brain suggest that experimental observations of the CBF response to changes in neural activation, inspired CO$_2$, and inspired O$_2$ all can be explained quantitatively by a simple principle: CBF regulation is maintaining a constant [O$_2$]/[CO$_2$] concentration ratio at the mitochondria. The proposed model may serve as a basis for interpreting the BOLD effect.

16:48 274. **Forepaw-Stimulation CBF and BOLD Response Under Hypoxia, Hyperoxia and Hypercapnia**

Kenneth M. Sicard, Qiang Shen, Zhaohui M. Liu, Timothy Q. Duong
1University of Massachusetts Medical School, Worcester, Massachusetts, USA

The BOLD fMRI signal is critically dependent on the underlying physiologic states. In this study, we used fMRI to systematically evaluate the BOLD and CBF changes in spontaneously breathing, isoflurane-anesthetized rats subjected to forepaw stimulation (a new forepaw stimulation model) under different inhaled gas conditions (9, 12, 21, 100%O$_2$, and 5, 10%CO$_2$) to modulate the baseline CBF and oxygenation saturation. Simultaneous measurements of BOLD and quantitative CBF were made using the continuous arterial spin-labeling technique with multislice echo-planar imaging acquisition. Forepaw-stimulation BOLD and CBF responses under different basal hypoxic, hyperoxic and hypercapnic conditions were evaluated.

17:00 275. **Experimental Separation of Intra and Extravascular BOLD Effects using Multi-Echo VASO and BOLD fMRI at 1.5T and 3.0T**

Hanzhang Lu, Peter C. van Zijl
1Johns Hopkins University, Baltimore, Maryland, USA

Quantitative interpretation of BOLD fMRI signals requires separation of intra- and extra-vascular contributions. Extensive theoretical studies have modeled such effects, but experimental data are still lacking because of difficulties separating blood and tissue signal contributions. We used an inversion recovery sequence to null the blood signal, thereby measuring predominantly extravascular signals and extravascular $R_2^*$ changes accompanying activation. When comparing extravascular and total $R_2^*$ changes in BOLD fMRI, the extravascular components were found to be 38% and 61% at 1.5T and 3.0T, respectively, in line with expectations that vascular BOLD effects are reduced at higher field.
The Linearity of CBV Response in Rat Whisker Barrel Cortex
Hanbing Lu1, David A. Soltysik2, B. Douglas Ward3, James S. Hyde1
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

CBV-weighted fMRI using iron-oxide contrast agent has superior sensitivity to BOLD contrast. More importantly, CBV-fMRI has the potential of detecting vascular response close to the foci of neuronal activity. The linearity of CBV-fMRI response is a fundamental issue regarding quantitative interpretation of CBV-fMRI data and paradigm design, but has not been well investigated. The present study investigates the linearity of CBV response. Results (n = 3) suggest that CBV response is linear between the stimulus durations of 2-32 sec, and the area-under-curve of the CBV response (y) to stimulus duration (x) can be fit with y=14.78x (R² = 0.99).

The contrast mechanism in fMRI results from several vascular processes with different timescales. In this work, we measured the BOLD and CBV impulse response (IR) in rats at high spatial and temporal resolution at 11.7T. Results show that the CBV IR is significantly narrower (1.6±0.2s), and peaks earlier (1.9±0.3s) than the BOLD IR (2.3±0.6s and 2.7±0.6s, respectively). This suggests there is a substantial effect of the transit of oxyhemoglobin to the BOLD IR in rats, and the neurovascular control mechanisms have a temporal resolution better than 1.5s. These results have important implications for the ultimately attainable temporal resolution of fMRI.

This study examined the feasibility of imaging cerebral metabolic rate of oxygen (CMRO2) in association with forepaw stimulation in spontaneously breathing rats under isoflurane anesthesia. Isoflurane was used because it provided stable physiology for repeated measurements. Spontaneous breathing was used because the animals could maintain their own physiology and blood gases. Simultaneous measurements of BOLD and CBF were made using the continuous arterial spin-labeling technique with multislice echo-planar imaging acquisition. CMRO2 was calculated pixel-by-pixel at each time point using Davis’s biophysical BOLD model. Stimulus-evoked CMRO2 changes were evaluated dynamically under graded forepaw stimulation currents.

We observed a significant effect of caffeine on the temporal dynamics of the BOLD hemodynamic response, in particular the enhancement of oscillations in the post-stimulus response. Because caffeine acts as a vasoconstrictor, we hypothesized that the observed effect reflected a decrease in the baseline arteriolar compliance. We modified a current biomechanical model for the BOLD response (an autoregulatory model for cerebral blood flow coupled with the Balloon model) to explicitly include the dynamics of arteriolar compliance. We show that a decrease in baseline compliance can predict the observed change in dynamics without a significant change in the other model parameters.

New Contrast Agents: Theory and Applications

Annex 2  16:00 - 18:00  Chairs: Patrick M. Winter and A. Dean Sherry

Paramagnetic CEST Agents: Imaging Sugar via the Bulk Water
Shanrong Zhang1, Robert Trokowski2, A. Dean Sherry3
1University of Texas Southwestern Medical Center, Dallas, Texas, USA; 2University of Texas at Dallas, Richardson, Texas, USA

Europium (III) complex of a DOTA-tetraamide ligand containing two phenyl boronate pendent arms was synthesized and characterized as a prototype of contrast agent for imaging sugar in tissues. Upon sugar binding, the exchange between single Eu³⁺-bound water molecule and bulk water was slowing down and this can be imaged by MRI using chemical exchange saturation transfer (CEST) imaging sequence. Therefore, it offers the possibility of high-sensitivity MR imaging sugars in tissues using bulk water protons as antenna.

Exploring New Routes for Sensitivity Enhanced MRI-CEST Agents
Silvio Aime1, Daniela Delli Castelli1, Enzo Terreno1
1University of Torino, Torino, Italy

CEST agents represent a novel and emerging class of diagnostic media for MRI applications. The main advantages of these agents over the conventional agents are: i) the ability to generate a contrast only following the irradiation of a frequency characteristic of a given CEST agent, and ii) the possibility to design responsive probes whose saturation transfer is not dependent on the absolute concentration of the CEST agent. In this contribution some example of high-sensitive CEST systems based on the molecular recognition between a diamagnetic molecule containing a high number of mobile protons and a paramagnetic shift reagent will be presented.
16:24 282. **A Phase 1 Trial of SR4554 as a Non-Invasive Probe of Tumour Hypoxia Detected by 19F Magnetic Resonance Spectroscopy**

Geoffrey Stephen Payne1, Chooi P. Lee2, Beatrice M. Seddon3, Ruth R. Ruddle2, Florence I. Raynaud2, Siow Tan4, Mieli J. Campbell2, Ian R. Judson4, Paul Workman2, Martin O. Leach1

1Royal Marsden NHS Trust and the Institute of Cancer Research, Sutton, Surrey, UK; 2The Institute of Cancer Research, Sutton, Surrey, UK; 3Cancer Research UK, London, UK

Tumour oxygenation plays a vital role in tumour response to therapy. Measurement with polarographic electrodes is invasive and sometimes unreliable. SR4554 is a fluorinated nitroimidazole, designed as a non-invasive tumour hypoxia marker, which is reduced and bound in hypoxic tissues. In 10 cancer patients treated at 1400mg/m² the plasma half-life was 3.9±1.0 hours. Mean 19F MRS signal at 16 hours relative to that immediately after administration was 11±7% (mean±sd), significantly higher than relative plasma concentrations (3.5±2.4%; p = 0.007). This demonstrates that the study is feasible in the clinical context, with SR4554 being selectively retained in some tumours.

16:36 283. **Fluorine Spectroscopy and Imaging of Unstable Atherosclerotic Plaque with Fibrin-Targeted Nanoparticles using Fast Balanced Techniques at 1.5T**

Shelton D. Caruthers5, Rolf Lameriche5, Patrick M. Winter1, Anne M. Morawski1, Frank P. Hockett1, Michael J. Scott1, Huaying Zhang1, Patrick J. Gaffney1, Samuel A. Wickline1, Gregory M. Lanza1

1Washington University School of Medicine, St. Louis, Missouri, USA; 2Philips Medical Systems, Best, Netherlands; 3St. Thomas’ Hospital, London, UK

Recognition and quantification of unstable atherosclerotic plaque burden may be required to determine whether early acute intervention is warranted to avert impending stroke or myocardial infarction. Fibrin-targeted paramagnetic perfluorocarbon nanoparticles, imaged at 1.5T, reveal fibrin deposits within intimal microruptures and correlate with 19F images from 4.7T. Herein, 1.5T MR spectroscopy and bFFE imaging of fluorine nuclei were used to assess perfluorocarbon mixtures and image (within one min/slice) fibrin-targeted nanoparticles in microthrombi in endarterectomy samples. These data suggest fluorine spectra and images can be obtained with clinically available MR systems to quantify biochemical signatures of disease that support clinical therapeutic decisions.

16:48 284. **α,βγ-Targeted Perfluorocarbon Nanoparticles Provide Molecular Imaging of Angiogenesis and Effective Targeted Drug Delivery**

Patrick M. Winter1, Anne M. Morawski1, Shelton D. Caruthers1, Thomas D. Harris1, Todd A. Williams1, John S. Allen1, Huaying Zhang1, Samuel A. Wickline1, Gregory M. Lanza1

1Washington University, St. Louis, Missouri, USA; 2Philips Medical Systems, Best, Netherlands; 3Bristol-Myers Squibb Medical Imaging, Billerica, Massachusetts, USA

This research demonstrates drug delivery and monitoring of therapeutic effect with T1-weighted MRI after systemic injection of α,βγ-targeted paramagnetic nanoparticles. Cholesterol-fed rabbits were treated with either α,βγ-targeted or non-targeted paramagnetic perfluorocarbon nanoparticles carrying fumagillin. At baseline, MRI enhancement (1.5T) was significantly higher with α,βγ-targeted vs. non-targeted nanoparticles. One week after treatment, enhancement in the non-targeted group was largely unchanged from baseline, while the α,βγ-targeted group showed very little enhancement. These results suggest that MR molecular imaging may provide 1) detection of early atherosclerosis, 2) effective targeted drug delivery and 3) assessment of therapeutic response.

17:00 285. **Tumor Imaging in a Mouse Xenograft Model of Human Adenocarcinoma Using a Novel Multimodal NIRF/MRI Probe**

Anna V. Moore1, Zdrovka O. Medarova1, George Dai2

1Massachusetts General Hospital and Harvard Medical School, Charlestown, Massachusetts, USA; 2MGH/MIT/HMS, Charlestown, Massachusetts, USA

This study describes the application a targeted multimodal NIRF/MR imaging probe, CLIO-EPPT, developed by our group, for tumor detection in mouse models of a number of human adenocarcinomas. CLIO-EPPT targets underglycosylated MUC-1 (uMUC-1), a tumor associated antigen, which becomes available early in carcinogenesis due to deregulated expression and glycosylation of normal MUC-1. In vivo MR and NIRF imaging was performed on animals bearing bilaterally-injected uMUC-1-positive and uMUC-1-negative tumors. CLIO-EPPT localized specifically to uMUC-1 expressing tumors and demonstrated favorable in vivo biodistribution. The imaging probe described in this abstract shows promise as the basis of a clinically relevant tool.

17:12 286. **MR Imaging of Low Density Lipoprotein and Folate Receptors**

Rong Zhou1, Hoon Choi1, Ian Corbin1, Seok Rye Choi1, Hui Li1, Brian Gray2, Jerry D. Glickson1, I-wei Chen1, Hank Kang1

1University of Pennsylvania, Philadelphia, Pennsylvania, USA; 2PTIR Research Inc., Exton, Pennsylvania, USA

Target-specific delivery of diagnostic and therapeutic agents can be achieved through modification of ligands whose uptake is mediated by receptors. For MR imaging of these receptors, two strategies were examined and validated: labeling low-density-lipoprotein (LDL) with a GdDTPA-based paramagnetic agent for imaging of LDL receptors and using a folate-conjugated superparamagnetic iron oxide nanoparticles for imaging folate receptors.
Detection of Pre-Symptomatic Prion Infection in the Mouse Spleen by MRI
Youssef Zaim Wadghiri1, Marcin Sadowski1, D Brown∗, Cheuk Ying Tang∗, Daniel H. Turnbull1, Thomas Wisniewski1
1NYU School of Medicine, New York, New York, USA; 2University of Bath, Bath, UK; 3Mt Sinai School of Medicine, New York, New York, USA

In prion diseases the very brief clinically symptomatic period in infected subjects, which rapidly leads to death, is preceded by months to years of pre-clinical prion replication in the spleen. The key element in the pathogenesis of prionoses is the conversion of normal host protein PrPC to the infectious PrPSc. PrP binds with high affinity to PrPSc. We tested the use of Gadolinium labeled short synthetic, non-toxic peptides homologues to PrP as specific ligands for MRI detection of PrPSc accumulation in the mouse spleen. Our results show that these MRI ligands allow identification of asymptomatic carriers of prion disease.

Detection of Vascular Endothelial Leakage in the Brain Stem Following Cardiac Arrest
Jeff W.M. Bulte1, Julia Kofler1, Jiangyang Zhang1, Susumu Mori1, Richard J. Trasstman1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

It is known that cardiac arrest and cardiopulmonary resuscitation can lead to an increase of the blood-brain barrier permeability. We administered USPIO particles in a mouse model of cardiac arrest, and observed numerous hypointense lesions upon MRI examination exclusively in the region of the brain stem. This contrast-enhancement pattern was absent in sham-operated animals receiving USPIO. Histology revealed leakage and accumulation of the iron oxide nanoparticles in endothelial cells. We conclude that cardiac arrest can lead to hitherto unreported damage of brain stem endothelial cells.

Modified HDL as Specific Carrier for MR Imaging of Atherosclerotic Plaques
Juan C. Frias1, Juan Gilberto S Aguinaldo1, Edward A. Fisher2, Kevin J. Williams3, John T. Fallon1, Zahi A. Fayad1
1Mount Sinai School of Medicine, New York, New York, USA; 2New York University, New York, New York, USA; 3Thomas Jefferson University, Philadelphia, Pennsylvania, USA

This new reconstituted HDL contrast agent represents an endogenous carrier that selective target atherosclerotic plaques. The study showed that the modified HDL produces an enhancement in the plaques that is noticeable at 1 hour post-injection and increases after 24 hours post-injection.

MR Spectroscopy of Acquired Brain Disease
Room D 16:00 - 18:00 Chairs: Linda Chang and Michael W. Weiner

Longitudinal Multi-Slice Short-TE 1H MRSI Reveals Ongoing Brain Metabolite Injury in Treated HIV+ Patients and in Chronic Heavy Drinkers
Dieter Johannes Meyerhoff1, Diana Truran, Derek Flenmiken, Enmin Song, Colin Studholme1, Michael W. Weiner1
1University of California San Francisco, DVA Medical Center, San Francisco, California, USA

Multi-slice short-TE 1H MR spectroscopic imaging was used in a longitudinal study of the effects of HIV infection and continued heavy drinking on brain metabolites. Results suggest that, while continued heavy drinking over 2 years is associated with widespread axonal and astrocytic damage, it does not appear to exacerbate ongoing adverse metabolite effects of HIV infection. Furthermore, untreated HIV infection is associated with ongoing neuronal injury, in particular in parietal WM. HIV patients on antiretroviral treatment show less severe longitudinal brain metabolite damage than untreated HIV+ patients, but even virally suppressed HIV+ patients tend to have ongoing regional NAA loss.

Time line Follow Back of Alcohol Consumption is Positively Correlated with Brain Choline Levels in Healthy Volunteers
Gabriele Ende1, Helga Welzel1, Sigrid Walter1, Karl Mann1
1Central Institute of Mental Health, Mannheim, Germany

The aim of this work was to determine significant correlations of choline-containing compounds with the amount of alcohol consumption within the last 90 days. In a group of healthy controls we found a significant positive correlation of frontal WM Ch (left and right) and anterior cingulate Ch with TLFB These results support the assumption that Ch changes reflect an adaptive mechanism of the brain to alcohol consumption. An initially increased turnover of phosphatidylcholine and other phospholipids might reflect an adaptive mechanism of the brain. Chronic alcohol consumption leads to membrane adaptation to minimize the fluidizing influence of alcohol.
Previous neuropsychological studies of children with type-1 diabetes have demonstrated reduced performance in tests of memory and executive skills. The neural correlates of these deficits are unclear. In a group of early onset diabetics, 12 years after diagnosis and study inception, MRS was used to examine the metabolic profiles of temporal lobe, frontal lobe and basal ganglia, regions associated with the observed neuropsychological deficits. Diabetic patients showed significantly increased concentrations of myoinositol, total choline and glutamate/glutamine in their frontal lobes, compared to non-diabetic controls. NAA was reduced in basal ganglia while temporal lobe metabolites were not different from controls.

Developmental delay (DD) refers to the delayed acquisition of cognitive, motor and adaptive functions in children. Often an etiology cannot be found for the mildest forms of DD. We compared MRSI of 7 patients diagnosed with cryptogenic DD to age matched controls. Spectra were evaluated from nine brain regions including gray matter, white matter and basal ganglia. Compared to the control group, significantly lower NAA/Cr and NAA/Cho ratios were found in each brain region from the DD group. Further studies will be required to determine a possible correlation with clinical outcome.

To investigate the relationship between in vivo bioenergetic impairment and alterations in electrophysiology in patients with temporal lobe epilepsy we correlated presurgical measurements of hippocampal PCr/ATP with cellular measures of dentate hyperexcitability, synaptic depression and Na+/K+ ATPase function from the resected tissue. Although we found no statistically significant correlation between the excitability of the tissue and synaptic depression with the bioenergetics, the rate of recovery of the membrane potential showed a highly significant correlation (p<0.007, R = 0.85) with PCr/ATP. The data suggest that adequate levels of PCr are critical in allowing the neurons to maintain the appropriate ionic gradients.

We investigated whether there are different or similar changes in NAA in pure primarily generalized tonic clonic epilepsy (GTCS) compared to juvenile myoclonic epilepsy (JME). Twenty patients with GTCS, twenty-six with JME, and ten matched healthy controls were investigated with quantitative single-voxel MR spectroscopy in cerebellum, thalamus, prefrontal and occipital cortex. Frontal lobe NAA was reduced in JME in relation to controls and GTCS-patients. In GTCS, on the other hand, thalamic NAA was reduced compared to controls. Both patient groups also had reduced thalamic choline and myo-inositol. This shows partly differentiated alterations within the thalamo-cortical loop in JME versus GTCS.

To better understand the cellular changes underlying decreased NAA in temporal epilepsy, we correlated in vivo presurgical hippocampal NAA/Cr ratios with histological measures of neuronal loss and astrocytic reaction from each of the CA1–4 sectors of the hippocampus. The strong correlation between NAA/CR and GFAP staining in all four CA sectors, without a correlation between NAA/CR or GFAP with neuronal loss suggests that decreases in NAA/Cr reflect recent or ongoing neuronal injury/impairment, not neuronal loss. These data indicate that NAA/CR measurements in temporal lobe epilepsy could provide a sensitive measure for assessing longitudinal changes in patients with temporal lobe epilepsy.
Graves’ disease is an autoimmune disease of the thyroid gland. Patients often have neuropsychiatric and cognitive complaints. Whether these symptoms disappear after treatment remains disputed. Previous studies in acute Graves’ disease showed reduced Choline and myo-Inositol. This prospective study reports MRS from a larger group of patients pre- and post treatment. The abnormalities found in the acute phase were reversible, with one exception: Glx remained reduced in white matter. Reduced Glx has previously been reported in dementia and depression, but whether the reduced Glx in the treated Graves’ disease patients plays a related role remains an open question.

We undertook 13C MRS of the brain after intravenous 1-13C glucose infusion in a small group of treated schizophrenics (SZ), to define hypothesized abnormalities in neuronal metabolism. 1-13C glucose appeared rapidly in the brain of SZ but its incorporation in the first product of neuronal TCA, Glutamate C2, appears much reduced compared to control. Overall oxidation rate of H13CO3 production, was not altered. While these findings are preliminary, and complicated by the possible effect of medication, the potential for further elucidation of this complex human brain disorder through 13C MRS is confirmed.

Measurement of Brain Oxidative Metabolism in Monkeys using 1H-NMR Spectroscopy without 13C Editing and Decoupling

1H PRESS was used to measure the TCA cycle flux VTCA in the striatum of primates using 13C-labeled glucose. Difference PRESS spectra revealed simultaneous decreases in 12C-bonded protons and increases in 13C-coupled protons of glutamate. A quantitation procedure based on LCModel analysis was implemented for proper measurement of both glutamate C4 and C3 enrichments. As a result, it was possible to accurately measure VTCA in a 3.9 cm³ voxel centered in the monkey brain on a 3 Tesla NMR system (VTCA = 0.55 ± 0.04 µmol.g⁻¹.min⁻¹, n=4) without 13C editing or decoupling.

Quantification of the [1-13C]Glycogen Signal in the Human Brain: The Turnover of Bulk Brain Glycogen is Very Slow

13C label incorporation into and wash-out from brain glycogen was measured in two healthy subjects using localized 13C NMR spectroscopy over two days after administration of [1-13C]glucose. For quantitation of the in vivo C1 glycogen signal, conditions permitting a reliable measurement were assessed and data are presented demonstrating a temperature dependence of the glycogen linewidth and integral using glycogen obtained from 3 different commercial sources. Quantifications taking these temperature dependent effects into account resulted in an estimate for human brain glycogen turnover times of several days to one week.

A Method to Improve the Spectral Resolution in Prostate Spectroscopy

Prostate cancer is the second leading cause of cancer type among men. Flexible balloon-type endorectal coils are generally employed for MRS to provide better SNR. These coils are inflated with air before the scan to provide wider coverage. However, at the tissue-air interface spectral resolution deteriorates due to susceptibility. This coincides with the peripheral zone where approximately 70% of cancerous tissue is developed. In this work we show that if the coil inflated with perflourocarbon (PFC) compound, the spectral resolution can be improved considerably. This leads to an improved sensitivity and specificity in prostate cancer diagnosis.
The upfield region of the human cerebral $^1$H-MR spectrum is well characterized in terms of metabolites and macromolecular baseline. In contrast, the downfield region contains resonances that are difficult to assign and distinguish between baseline and low-molecular-weight metabolites in healthy subjects and phenylketonuria patients. A large portion of the downfield resonances was found to be due to short-T1 components. Peaks assignable to NAA, homo-carnosine and ATP were found in the metabolite spectrum, while those expected for creatine and glutamine were absent.

In quantitative in vivo NMR spectroscopy, spectra are fit with a model to estimate relevant parameters. Cramer-Rao bounds are often used to measure the error associated with the parameter estimation. This method generally gives good results but may be inaccurate in some situations. In this work, a computer-intensive statistical method called the bootstrap is used to measure the variance of parameters estimated in fitting NMR spectra. In Monte Carlo simulations and in vivo spectra, the bootstrap performs comparably to Cramer-Rao. This demonstrates an alternative means of measuring parameter variance, and can be used to validate or replace the Cramer-Rao method.

As MRS longitudinal studies are increasingly common, tight control of the reproducibility of the measurements becomes extremely important. Since fitting is always involved in quantifying MRS data, it has usually been assumed that SNR is a factor contributing to the variance of the determined metabolite concentrations. We show here that spectra collected from healthy volunteers do not confirm this assumption. We hypothesize that the other sources of variability encountered in vivo are much more significant, and unless they are carefully controlled (through automated voxel repositioning, eg.), increasing the SNR of an acquisition does not improve measurement reproducibility.

We present a novel approach for spectral editing which employs a single PRESS (S-PRESS method) sequence. Since the spectral shape of a strongly coupled spin system under PRESS excitation depends not only on the echo time but also on the interpulse delays, by means of density matrix simulations it is possible to identify an echo time such that two different interpulse delays will result in two completely different spectra, because of the J-modulation. This interpulse-delay dependent J-modulation is demonstrated theoretically and it is then verified experimentally on an AB system (citrate) and on an I2S2W2 system (GABA).

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Vitamin C, GPC, GPE, PC, and PE were resolved separately in vivo in MEGA-PRESS edited spectra at 4T. The goal of this study was to quantify all the resonances appearing in the spectrum edited for Vitamin C using LCModel. LCModel analysis with all compounds (including GPC and GPE) in the basis set provided an excellent reproduction of the in vivo spectral pattern. This study illustrates that vitamin C can be quantified with a precision of 10% (average CRLB) with the method described and simultaneously measured with 7 additional compounds.

Myocardial Perfusion and Oxygen Consumption

Room B-1  16:00 - 18:00  Chairs: Leon Axel and J. Paul Finn

16:00 310. Cardiac First-pass Perfusion MRI using 3D trueFISP Parallel Imaging using TSENSE

Peter Kellman1, Qiang Zhang2, Andrew C. Larson1, Orlando P. Simonetti3, Elliot R. McVeigh1, Andrew E. Arai1
1National Institutes of Health, Bethesda, Maryland, USA; 2Siemens Medical Solutions, USA, Chicago, Illinois, USA

Coverage of the entire heart during first-pass contrast enhanced MRI with single heartbeat temporal resolution is desirable for quantifying perfusion abnormalities. Current imaging protocols limit the ability to image the entire heart with single heartbeat temporal resolution, particularly at high heart rates. Parallel imaging is applied to provide 3d coverage of the heart with single heartbeat temporal resolution. The method combines saturation recovery true-FISP imaging with rate R=6 acceleration using 2d TSENSE. Unlike multi-slice 2d perfusion imaging, 3d imaging is performed in end-diastole, thereby enabling a longer saturation preparation time (TI) for improved contrast-to-noise ratio (CNR) and flatter response.

16:12 311. RR-UNFOLD: Respiratory Reordered UNFOLD for First Pass Myocardial Perfusion Imaging

Nicholas A. Ablitt1, Peter D. Gatehouse2, Guang-Zhong Yang2
1Imperial College London, London, UK; 2Royal Brompton Hospital and National Heart & Lung Institute, Imperial College London, London, UK

The assessment of myocardial perfusion requires accurate Quantification of the transmural extent of possible defects, UNFOLD is an image acquisition and reconstruction method which attempts to encode spatial information into redundant regions of k-t space. This paper presents a novel approach to the acquisition and reconstruction of MR myocardial perfusion images based on UNFOLD with prospective respiratory phase encode reordering. It provides an adaptive real-time binning method that minimises motion artefacts due to respiration whilst maintaining the temporal tissue characteristics during the contrast up-take. The method is validated on 10 patients with detailed quantitative comparisons.

16:24 312. Fat-Suppression Improves Image Quality and Diagnostic Accuracy of EPI First Pass Perfusion

Wiphada Patricia Ingkanisorn1, Kenneth L. Rhoads1, Mushabbar A. Syed1, Christopher K. Dyke2, Peter Kellman1, Anthony H. Aletras1, Andrew E. Arai1
1National Institutes of Health, Bethesda, Maryland, USA

We hypothesized that application of a chemical shift fat saturation pulse would decrease EPI artifact and improve overall image quality of first-pass cardiac perfusion imaging. Results: Artifact averaged 38% of peak myocardial SNR for the standard FGRE-EPI technique but only 9% for fat-saturation studies (p < 0.001). The diagnostic accuracy of dipyridamole CMR perfusion in detecting coronary artery disease improved from 72% with the standard FGRE-EPI technique to 84% with the fat-saturated technique. Conclusion: Fat saturation perfusion significantly improves image quality and the diagnostic accuracy of CMR in the detection of coronary artery disease.

16:36 313. Dual T$_1$-Sensitivity Quantitative High-Dose First-Pass Gd-DTPA Myocardial Perfusion

Peter D. Gatehouse1, Andrew G. Elkington1, Nicholas A. Ablitt2, Taigang He1, Guang-Zhong Yang2, Dudley J. Pennell1, David N. Firmin1
1Royal Brompton Hospital, London, UK; 2Imperial College, London, UK

A trial in 15 patients compared the new method, optimizing measurement of the arterial input function (AIF) and myocardial signal-time curve (STC) during the same high-dose first-pass, with the serial dual bolus method. Improvements in AIF measurement by the new method are pointed out, and rest/stress MPR assessment comparison showed close agreement between the two methods.
Late Enhancement of Infarct May Overestimate Myocardial Ischemia in Stress/Rest MR Perfusion Imaging
Fadi M. EL-Merhi1, Jie Zheng1, George S. Chrysant1, Faith E. Rowold1, Robert J. Gropler2, Pamela K. Woodard2
1Washington University School of Medicine, St. Louis, Missouri, USA

The impact of late enhancement of infarcted myocardial tissue on MR perfusion defect reversibility has not yet been explored. This study demonstrates that after contrast administration for stress MR perfusion imaging, the CNR of infarcted myocardial territory to normal myocardium is significantly less than when rest MR perfusion imaging is performed alone (without any prior contrast administration). Given that delayed-enhanced myocardial imaging accurately shows infarcted myocardial tissue, rest perfusion MR imaging performed after adenosine stress perfusion MR imaging in a subjective clinical setting may be redundant, if not misleading.

Effects of Water Exchange on MR Quantification of Regional Myocardial Blood Flow using an Intravascular T₁ Contrast Agent
Sabin Carne1, Marlene Wiart1, Henrik Larsson2, Bruno Neyran1, Emmanuelle Canet-Soulas1
1Creatis UMR CNRS 5515, Lyon, France; 2St Olav Hospital, Trondheim, Norway

The aim of our study was to quantitatively investigate the effects of water exchange between the vascular and extravascular compartment on myocardial perfusion quantification when using an intravascular contrast agent in pigs. Results confirm the dependency of perfusion measurements on water exchange regimen hypothesis. Myocardial perfusion was best approximated using fast exchange regimen though R₁ analysis overestimated perfusion for rest and stress conditions when compared to microsphere results. Since water diffusion impact cannot always be neglected, caution should be taken when designing perfusion MR sequences in order to minimize these effects and thus increase the accuracy of perfusion estimates.

Breath-hold Arterial Spin Labeling TrueFISP MRI of Myocardial Perfusion
Jing An1, Pippa Storey1, Raymond Huang1, Qun Chen1
1NYU School of Medicine, New York, USA; 2Evanston Northwestern Healthcare, Evanston, Illinois, USA

We present a breath-hold arterial spin labeling (ASL) true FISP imaging method for the quantitative mapping of myocardial perfusion. In the current implementation, a segmented TrueFISP sequence was combined with a FAIR imaging technique, in which slice-selective and slice-nonsselective inversion pulses were applied alternately to generate two sets of images (control and labeled) in a single breath-hold cardiac trigger scan. The image data were then analyzed using a theoretical model to generate quantitative information of myocardial perfusion. This ability of MRI to quantitatively measure regional myocardial perfusion may have significant impact in the evaluation of ischemic heart disease.

MR Feasibility Study of Global Left Ventricular Myocardial Oxygen Consumption in Normal Volunteers: Preliminary Results
Yuesong Yang1, Warren Foltz1, Juiimin Hong1, Jeff Stainsby1, Rohan Dharmakumar1, Naem Merchant1, Graham A. Wright1
1Sunnybrook and Women's College Health Science Centre, Toronto, Ontario, Canada; 2University Health Network, University of Toronto, Toronto, Ontario, Canada

Most frequently used left ventricular (LV) function parameters, such as LV ejection fraction only reflect the systolic function of the LV. Myocardial oxygen consumption (MVO2) may be a better functional parameter than LVEF as it reflects the overall myocardial oxidative metabolism. In this study we combined MR coronary sinus oximetry calibrated by in vitro blood characterization, cine phase contrast flow volume measurement, and LV mass estimate. We thus obtained MVO2 values non-invasively based on Fick’s law. The initial results showed the feasibility of this MR technique in the evaluation of global LV MVO2 in normal volunteers.

Dynamic Assessment of Myocardial Oxygen Consumption by MRI
Jie Zheng1, Mark Nolte1, Vivian S. Park1, Faith E. Rowold1, Pamela K. Woodard1, Robert J. Gropler1
1Washington University School of Medicine, St. Louis, Missouri, USA; 2Washington University, St. Louis, Missouri, USA

The aim of this study is to develop MR methods for accurate measurement of myocardial oxygen consumption (MVO2). The study was performed in a canine model with and without coronary artery stenosis (70%). Myocardial and blood T1 were measured with a fast T1 method and a new algorithm for the calculation of myocardial blood flow (MBF). MVO2 was quantified using myocardial oxygen extraction (OEF) and MBF, at rest and during dipyridamole induced vasodilatation. Dynamic changes in MVO2 in normal dogs correlated well with heart rate-pressure product. Stenotic perfused regions show slightly increased, but not significant, MVO2 after the vasodilatation.

Clustering and Pixelwise Methods for Improved Parametric Analysis of Dynamic Contrast MRI Studies
Edward DiBella1, Dmitri Y. Riabkov1, Eugene G. Kholmovski1, Prashanthi Vemuri1
1University of Utah, Salt Lake City, Utah, USA

A typical approach to analyze dynamic studies is to divide the myocardium or other area of interest uniformly into a relatively small number of segments in each slice. Four methods are compared here for improving parametric analysis of such dynamic data: uniform division of a myocardial slice into 8 regions, k-means clustering, pixelwise fitting with unfiltered data, pixelwise fitting after anisotropic diffusion filtering, and pixelwise fitting after principal component filtering. These methods show promise for improved parameter estimates from dynamic cardiac perfusion data.
JAPANESE LANGUAGE SUMMARY SESSION
Basic Science Highlights
Room B-1 18:00 – 19:30

JAPANESE LANGUAGE SUMMARY SESSION
New Clinical Developments
Room B-2 18:00 – 19:30

BRONZE CORPORATE MEMBER SYMPOSIUM
Bruker BioSpin MRI, Inc.
Translational Imaging Strategies to Optimize Drug Discovery
Annex 1 18:15 – 19:45
Speaker: Richard Hargreaves, Merck & Co., Inc.

BRONZE CORPORATE MEMBER SYMPOSIUM
Tyco Healthcare Mallinckrodt
Clinical Applications of MR Contrast Delayed-Enhancement
Annex 2 18:15 – 19:45
MORNING CATEGORICAL COURSE
Functional Body MR: From Morphology to Function

Sakura 07:00 – 08:00 Chairs: Riccardo Manfredi and Carlo Bartolozzi

Educational Objectives
Upon completion of this course, participants should be able to:
• Evaluate new pulse sequences based on knowledge of current MR technique, and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Incorporate recent developments for MR imaging such as MRCP for the pancreas and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Apply new contrast agents in different hepatic diseases;
• Evaluate the possibility of MR imaging in bowel imaging and in screening oncologic patients for metastatic disease;
• Achieve functional information reflecting physiologic processes.

07:00  Liver and Liver-Specific Contrast Agents
Thomas Helmberger

07:30  Biliary and Pancreatic Ducts
Alice Gillams

MORNING CATEGORICAL COURSE
Understanding Diffusion Imaging and Functional MRI: The Relationship between Structure and Function in the Brain

Room A 07:00 – 08:00 Chairs: Gareth J. Barker and R. Todd Constable

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain how the fMRI data are acquired and processed;
• Explain how the diffusion tensor is acquired, measured and mapped;
• Define the terms structural and functional connectivity;
• Describe sources of artifacts, limitations to the data, and the likely impact of new parallel imaging techniques on fMRI and DTI data;
• List methods available to combine the complementary information from fMRI and DTI data.

The final five minutes of each presentation will be reserved for questions.

Introduction to DTI
07:00  DTI Basics
Derek K. Jones

07:30  Tractography and Beyond
Geoff Parker

MORNING CATEGORICAL COURSE
Echo Management

Room D 07:00 – 08:00 Chairs: Kim Butts and Scott D. Swanson

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain the basic principles of spin echo, gradient echo, and stimulated echo formation;
• Appreciate the complexity of coherence pathways that arise when two or more RF pulses are applied;
• Describe methods that investigators use to mitigate effects of multiple coherence pathways to assure formation of proper echoes;
• List techniques used in steady-state free precession (SSFP) pulse sequences to minimize spurious echo formation;
• Determine which sequence will be appropriate for what clinical application.

07:00  Basic FSE/TSE and FLARE  
David G. Norris

07:25  Advanced FSE/TSE  
Jürgen Hennig

07:50  Discussion

MORNING CATEGORICAL COURSE
Established and Evolving Applications of MR Angiography

Annex 2  07:00 – 08:00  Chairs: J.F.M. Meaney, M.R. Prince, S.O. Schoenberg

Educational Objectives
Upon completion of this course, participants should be able to:
• Define the established indications for MRA;
• Recognize the importance of non-contrast and contrast-enhanced approaches in the different vascular territories;
• Diagnose common vascular pathology and variants;
• Apply the different post-processing algorithms to enhance diagnostic practice;
• Perform basic vessel wall imaging.

MRA Post-processing Workstation Demonstration - Speakers to be announced
07:00  Philips Medical Systems

07:10  GE Medical Systems

07:20  Siemens Medical Solutions

07:30  Vital Images

07:40  Toshiba

07:40  Panel Discussion

MORNING CATEGORICAL COURSE
New Horizons in Musculoskeletal Imaging: Optimizing MRI With Current Technology

Room B-1  07:00 – 08:00  Chairs: Joshua M. Farber and Lawrence M. White

Educational Objectives
Upon completion of this course, participants should be able to:
• Describe MR techniques for imaging cartilage at various field strengths and understand the clinical role of MRI in the evaluation of articular cartilage disorders;
• Assess the musculoskeletal system using high and low field MR systems;
• Explain and use fat suppression MRI techniques in the musculoskeletal system;
• Explain and use fast scanning MRI techniques in the musculoskeletal system;
• Apply knowledge of high resolution MRI, and its trade-off with signal-to-noise, to imaging the musculoskeletal system;
• Describe the rationale of protocol approaches and apply this understanding to optimize MRI clinical protocols.

07:00  Fat Suppression Techniques in Musculoskeletal MRI  
       John A. Carrino

07:25  Fast Imaging Techniques in Musculoskeletal MRI  
       Joshua M. Farber

07:50  Discussion

MORNING CATEGORICAL COURSE  
Parallel Imaging 2004  
Annex 1 07:00 – 08:00  Chairs: Neil M. Rofsky and Daniel K. Sodickson

Educational Objectives  
Upon completion of this course, participants should be able to:  
• Explain the basic principles of parallel imaging, including elements both of RF coil array design and image reconstruction;  
• Critically survey promising applications of parallel MRI;  
• Summarize recent research into the limits of performance of parallel imaging, describe new developments in image reconstruction and coil array design, and outline emerging parallel imaging applications;  
• Identify the key steps in a practical parallel imaging examination, and compare the nuts-and-bolts features of various MR vendors' existing implementations.

Clinical Applications  
07:00  Recap of Basics  
       Daniel K. Sodickson

07:05  Applications in Clinical Cardiology  
       Scott D. Flamm

07:30  Applications in Clinical Radiology  
       Stefan O. Schoenberg

07:55  Discussion

MORNING CATEGORICAL COURSE  
MR Spectroscopy: The Brain and Beyond  
Room B-2 07:00 – 08:00  Chairs: Peter S. Allen, John R. Griffiths, Rolf Gruetter

Educational Objectives  
Upon completion of this course, participants should be able to:  
• Describe the principles of spectral analysis through LC modeling;  
• Outline the mechanisms for intra-sequence signal loss when target metabolites have coupled spins;  
• List the key metabolites facilitating the spectroscopic recognition of tumor development in the prostate and the brain;  
• Outline how water can be used as an internal concentration standard with minimal associated spectral artifacts;  
• Explain how macromolecular contamination of spectra can be recognized and mitigated;  
• Explain how MRS can be used to reflect metabolic processes in muscle using glycogen or lipids.

07:00  MRS in Cancer of the Prostate  
       Daniel Vigneron

07:20  Discussion
PLENARY LECTURES
MR in Screening

Main Hall  8:15 - 9:30  Chairs: R. Manfredi, J.F.M. Meaney, N.M. Rofsky

8:15  320.  Disease Screening in the 21st Century:  Is it Viable and What are the Tools?
Bruce J. Hillman1
1University of Virginia, Charlottesville, Virginia, USA

There is a general misunderstanding in the populace, and even among many knowledgeable physicians, about the validity of screening asymptomatic individuals for disease. The lay media and marketing forces have projected screening as inevitably positive, however, the success of screening depends on a complex interplay of factors. This presentation focuses on some of the pitfalls of screening and why technologies fail to succeed in a screening role. It will consider the prospects for magnetic resonance as a screening technology, evaluate advances in biology and technology that may enhance the likelihood of success, and chart a path for evaluating MR screening.

8:40  321.  MR Screening in Cardiovascular Disease
Zahi Adel Fayad1
1Mount Sinai School of Medicine, New York, New York, USA

The use of imaging methods for disease screening and for quantification of progression and regression of atherothrombosis could play an important role in the management of patients. CMR imaging has the potential to provide anatomical information about the lumen and the vessel wall. Furthermore, CMR has the ability to characterize plaque composition and therefore to identify lesions at risk to rupture or erosion. The high resolution of CMR and the development of sophisticated contrast agents offer the promise of in vivo molecular imaging of the plaque. This may aid early intervention in both primary and secondary treatment of vascular disease.

9:05  322.  Screening for Cancer with MRI and Conventional Imaging
Christiane K. Kuhl1
1University of Bonn, Bonn, Germany

In the field of oncology, screening tests target at identifying cancers in asymptomatic, presumably healthy individuals. The aim is to detect cancer in its preclinical stage in order to improve prognosis and avoid disease-specific complications. The only cancer type for which imaging studies are used for mass screening is breast cancer. At the same time, this is the only cancer for which experiences exist regarding the use of MRI for screening. This lecture serves to provide an overview on the effectiveness of breast cancer screening methods by conventional methods (mammography, clinical breast examination) compared to MR imaging.

Limits in Parallel Imaging

Main Hall  10:30 - 12:30  Chairs: Mark A. Griswold and Klaas Pruessmann

10:30  323.  Young Investigator Awards Finalist: Parallel Imaging Performance as a Function of Field Strength – An Experimental Investigation using Electrodynamic Scaling
Florian Wiesinger1, Pierre-Francois Van de Moortele1, Gregor Adriany1, Nicola De Zanche1, Kamil Ugurbil1, Klaas Paul Pruessmann1
1ETH and University Zurich, Zurich, Switzerland; 1University of Minnesota, Minneapolis, Minnesota, USA

In this work, parallel imaging performance was experimentally investigated as a function of field strength. Based on mimicking RF electromagnetic fields by proper adjustment of dielectric material properties, field strengths between 1.5T and 11.5T were mimicked in terms of RF characteristics. This permitted performing the investigation with a single experimental setup, consisting in a 7T scanner, an 8-element coil array and a spherical phantom. Most importantly, it was found that parallel imaging performance does improve significantly with increasing field strength. The experimental results are in agreement with previous theoretical predictions about ultimate SNR in parallel imaging.
Continuous moving table MRI techniques are of increasing interest for improving patient comfort and supporting new applications in whole body imaging. A combination with parallel imaging based on SENSE promises a substantial increase in imaging speed or spatial resolution. A stationary receive coil array covers an arbitrarily extended virtual field of view (vFOV). Complex coil sensitivity patterns are derived for the vFOV such that a standard SENSE reconstruction is applicable. The scheme is adaptable to any phase encoding direction and advanced acquisition order. 3D head-to-foot imaging in one minute of acquisition time is presented.

Application of SENSE to Continuously Moving Table MRI: Demonstration of Feasibility
Houchun Harry Hu¹, Ananth Jayasseelan Madhuranthakam¹, David G. Kruger², James F. Glockner², Stephen J. Riederer¹
¹Mayo Clinic College of Medicine, Rochester, Minnesota, USA

SENSE is a means for allowing improved spatial resolution in MRI. Thus far SENSE has been applied in instances in which the object and receiver coils are stationary. The purpose of this work was to apply SENSE to acquisitions done during continuous table motion. This can be particularly useful in improving the lateral spatial resolution of contrast-enhanced MRA of the peripheral vasculature. Technical challenges in implementation include accounting for data misregistration, correction of the increased complexity of gradient non-linearities in moving vs. fixed table acquisition, and formation of accurate coil sensitivity maps. Experimental results are presented which demonstrate feasibility.

Controlled Aliasing in 3D Parallel Imaging (2D CAIPIRINHA)
Felix Breuer¹, Martin Blaimer¹, Matthias Müller¹, Robin Heidemann¹, Mark Griswold¹, Peter Jakob¹
¹Universität Würzburg, Würzburg, Germany

In this abstract we show that aliasing artifacts in 3D parallel imaging can be manipulated in a controlled manner, resulting in a significantly improved reconstruction procedure. This is realized by modifications of the gradient tables in the 3D phase encoding direction. 2D CAIPIRINHA (Controlled Aliasing In Parallel Imaging Results IN Higher Acceleration) exploits coil sensitivity variations along multiple dimensions more efficiently than conventional 3D parallel imaging methods.

Twelve- to Sixteen-Fold Accelerations of Contrast-Enhanced MRA Using Highly Parallel MRI with a 32-Element Array
Daniel K. Sodickson¹, Christopher J. Hardy², Yudong Zhu³, Randy A. Giaquinto², Gontran Kenwood², Thoralf Niendorf⁴, Hubert Lejay⁵, Michael J. Harsh⁵, Charles A. McKenzie⁶, Norman Farrar⁵, Michael A. Ohliger⁴, Aaron K. Grant¹
¹Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; ²General Electric Global Research Center, Niskayuna, New York, USA; ³General Electric Medical Systems, Milwaukee, Wisconsin, USA; ⁴Harvard-MIT Division of Health Sciences and Technology, Cambridge, Massachusetts, USA

A 32-channel MR system and a 32-element array capable of highly parallel imaging were used to accelerate volumetric contrast-enhanced MR angiography studies of pulmonary, renal, and peripheral vessels by more than an order of magnitude in a series of adult subjects. Two-dimensional accelerations of 3D spoiled gradient echo sequences were used to achieve net acceleration factors between 12 (4x3) and 16 (4x4). As a result, otherwise impractically large volumetric coverage (approximately 40 cm x 40cm x 40cm) was achieved, allowing visualization of entire arterial trees at clinical spatial resolution and/or several-second temporal resolution.

Segmented Spiral Parallel Imaging Using GRAPPA
Keith Arron Heberlein⁶, Yasser Kadah⁷, Xiaoping Hu⁸
⁶Emory University, Atlanta, Georgia, USA

Efficient and robust reconstruction techniques, in both image space and k-space, have been developed for parallel imaging with Cartesian k-space sampling. For non-Cartesian sampling, such as spiral trajectories, only image domain reconstruction has been described; the image domain reconstruction, which is usually iterative, is computationally expensive. This paper describes and demonstrates a robust k-space reconstruction approach for parallel imaging with spiral trajectories; this new method is non-iterative, and shown to be robust and efficient.

Beyond the G-Factor Limit using Joint Entropy
David J. Larkman¹, Daniel Rueckert, Philipp G. Batchelor¹, Jo V. Hajnal¹
¹Hammersmith Hospital, Imperial College London, London, UK; ²King's College London, London, UK

The maximum practical speed-up that can be achieved using parallel imaging methods is widely accepted to be limited by g-factor noise. Use of joint entropy between a reference image and a SENSE image allows noise to be reduced. The reference image does not need to have the same resolution or contrast, the data acquired to determine coil sensitivities may be suitable. Tests on simulated array coil data with high g-factor, using a variety of contrast and resolution combinations preserved all image structure contrast and lesions even when not present in the reference data. G-factor was reduced to close to unity.
12:02  330.  **Coil Phase Compensation for Single Echo Acquisition (SEA) Imaging**  
Mary Preston McDougall1, Steven M. Wright1  
1Texas A&M University, College Station, Texas, USA

Using an array of 64 coils and a prototype 64 channel receiver we have previously demonstrated the ability to obtain an entire image from a single echo acquisition. In this technique, the coil size is on the order of the voxel dimensions and the phase pattern of the array elements must be counteracted using a coil phase compensation pulse. This paper describes this phenomenon and gives calculated and measured results confirming its impact on SEA imaging, showing the effect of the compensation pulse on signal-to-noise ratio and spatial frequency content.

12:14  331.  **RF Power Reduction with Parallel Excitation**  
Yudong Zhu1  
1GE Global Research Center, Niskayuna, New York, USA

MRI commonly employs a volume transmit coil to maximize B1 homogeneity. This approach may face SAR or flip angle uniformity issues with certain sequences or at high field strength. A parallel transmit system facilitates fast creation of desired flip angle distributions. Here we examine its further impact on SAR management. Conceptually, a focused excitation of the ROI only may primarily use nearby coils hence avoiding excessive power deposition. Given a flip angle profile, we show explicitly a parallel RF pulse design can exploit the extra degrees of freedom inherent of the system to tailor the E field and reduce SAR.

**CLINICAL CATEGORICAL COURSE**

**Hot Topics in Clinical MR Imaging**

Room A  10:30 – 12:30  Chair: Thomas M. Grist and Clifford R. Jack

**Educational Objectives**

Upon completion of this course, participants should be able to:

- Describe five points that can be used to improve imaging strategies in important areas of clinical practice;
- Assess the applicability to clinical practice of three newer imaging techniques.

**Neurological Imaging**

10:30  **Clinical High Field Neuro MRI: Ready for Prime Time**  
Lawrence N. Tanenbaum

10:50  **State of the Art Clinical MRS Techniques**  
John D. Port

11:10  **Presurgical Planning with Anatomic, Physiological and Functional MRI at 3T**  
Keith R. Thulborn

**Body Imaging**

11:30  **How I do Musculoskeletal MRI at 3T**  
Garry E. Gold

11:50  **How I Use Time-Resolved MRA in Clinical Practice**  
Frank J. Thornton

12:10  **How I Assess Myocardial Viability**  
Hajime Sakuma

12:30  **Adjournment**
Diffusion Tensor Imaging in the Developing Brain

Annex 1  10:30 - 12:30  Chairs: Jeffrey J. Neil and Susumu Mori

10:30  332. Voxel Based Analysis of Diffusion Tensor Imaging in Early Human Brain Development

Slava Zimine, Petra S. Huppi, Francois Lazeyras
1University Hospital of Geneva, Geneva, Switzerland; 2Children's Hospital Geneva, Geneva, Switzerland

Diffusion tensor imaging is a powerful tool to assess microstructural changes occurring during early brain development. The studies performed so far have used a priori ROI selection for measurement of quantitative changes in ADC and Anisotropy. This approach may be biased due to ROI selection, which makes it problematic in group comparisons. We therefore used a voxel-based-analysis approach to globally detect regions of significant maturational changes in human brain development in premature infants studied shortly after birth and again at term.

10:42  333. Quantitative DTI Fiber Tracking of White Matter Pathways in Premature Newborns

Jeffrey I. Berman, Pratik Mukherjee, Savannah C. Partridge, Steven P. Miller, Donna M. Ferriero, Anthony J. Barkovich, Dan B. Vigneron, Roland G. Henry
1UC San Francisco, San Francisco, California, USA

Diffusion tensor imaging (DTI) of premature infants provides an opportunity to study the development of white matter pathways prior to and during myelination. The corticospinal tract and somatosensory radiation were delineated with DTI fiber tracking in 13 premature infants imaged between 29 and 43 weeks gestational age, including serial studies in 6 infants. Tract-specific measures of diffusion, based on the location of DTI fiber tracks, showed an increase in FA and decreases in Dav and eigenvalues with increasing gestational age (p<0.003). The spatial heterogeneity of diffusion parameters along the white matter pathways were also studied as a function of age.

10:54  334. White Matter Pathway Asymmetry Corresponds to Auditory Spatial and Language Lateralisation

Thomas Richard Barrick, Ian Nigel Lawes, Christopher Alan Clark
1St George's Hospital Medical School, London, UK

The planum temporale, a region of auditory cortex known to sub-serve language is located on the superior surface of the temporal lobe. Typically the planum temporale is larger in the left hemisphere, language function is left lateralised, and auditory spatial localisation is lateralised to the right hemisphere. In the first investigation of diffusion tensor images to combine voxel based morphometry and fibre tracking techniques we determine the asymmetry of white matter pathways beneath the planum temporale. Furthermore, we demonstrate that these asymmetries may be localised to specific white matter pathways that correspond to known functional differences between the hemispheres.

11:06  335. White Matter Maturation from Birth to Adulthood: Evaluation with Fractional Anisotropy, Color Map and Diffusion Tensor Tractography

Kazuyuki Ohgi, Masayuki Motonishi, Akiyoshi Yamashita, Takashi Furukawa, Kouichirou Murata, Katsuhito Gotoh, Tomoko Matsubara, Minako Higashi, Syuhei Takehoto
1Japanese Red Cross Medical Center, Shibuya-ku, Tokyo, Japan; 2Kitasato-Institute Hospital, Tokyo, Japan; 3Toshiba Medical Systems Corporation, Otawara, Tochigi, Japan

This study illustrates various aspects of white matter maturation of the human brain evaluated with fractional anisotropy (FA), directionally-encoded color FA map, and diffusion tensor (DT) tractography. These DT techniques can be a new landmark of white matter maturation, and have a potential of providing valuable information in the assessment of white matter pathology.

11:18  336. Diffusion Tensor Imaging of Neurodevelopment in Adolescents and Young Adults

Lindsay Snook, Lori Ann Paulson, Dawne Roy, Yusuf A. Bhagat, Simon McCrea, Linda Phillips, Christian Beaulieu
1University of Alberta, Edmonton, Alberta, Canada

DTI has proven to be sensitive to developmental changes in the brain. Region-of-interest measurements were taken in 22 brain regions in 32 children of 8-12 years and 8 adults of 21-25 years. Linear regression analysis was performed on the children, and then group analysis was performed comparing the age groups. Significant changes in FA and trace ADC were seen in several brain regions. The measurements suggest regional differences in timing of brain maturation since some brain regions observed to show changes in FA between 8-12 years of age did not show changes at older ages of 21-25 years, and vice-versa.
11:30 337. Tracking Healthy Babies' White Matter Fibers Despite Low Anisotropy: A Feasibility Study
Jessica Dubois1, Lucie Hertz-Pannier2, Stéren Chabert1, Carlos Meca1, Franck Lethimonnier1, Paola Scifo3, Francis Brunelle1, Ghislaine Dehaene-Lambertz2, Denis Le Bihan1
1CEA, Orsay, France; 2Necker-Enfants Malades Hospital, Paris, France; 3San Raffaele Hospital, Milan, Italy; 4INSERM, Orsay, France

Despite low or absent white matter myelination at birth, fiber bundles seem to be early organized in babies. Brain development studies require specific methods like DTI which has the potential to monitor organization and myelination process. However, the low degree of water diffusion anisotropy might prevent the successful tracking of incompletely myelinated bundles. Our aim was to establish whether reliable tracking is feasible on 3 months old healthy babies. Using DTI, ADC and FA of several bundles were measured, and fibers could be tracked. This study demonstrates tracking is feasible on fibers with FA as low as 0.33 in babies.

11:42 338. Age Dependence of the Fractional Anisotropy of Genu and Splenium of Human Corpus Callosum Using Optimized DT-MRI
Khader M. Hasan1, Bhavik P. Kanabar2, Rafeal M. Santos1, Linda Ewing-Cobbs1, Ponnada A. Narayana1
1University of Texas, Houston, Texas, USA; 2UH, Houston, Texas, USA

The corpus callosum (CC) is the largest interhemispheric commissure and plays a vital role in corticocortical communication. We have used an optimized DT-MRI acquisition protocol and a sophisticated DT-MRI ROI tool that implemented the Witelson subdivisions of CC to assess the anisotropy values in 65 volunteers in 9-69 year age range. The splenium FA showed age-independent values, whereas the genu FA values increased to reach a maximum at age ~ 28 yrs. These trends highlight the need to incorporate the age-dependence of regional FA values in the interpretation of FA in neurological disorders.

11:54 339. Reduction of Fractional Anisotropy in Frontal White Matter in Prenatally Cocaine Exposed Children
Kyle R. Padgett1, Fonda D. Eyler1, Marylou Behnke1, Christiana M. Leonard1, Kenneth M. Crandall1, Thomas H. Mareci1, Ty A. Black1, Ilona M. Schmalfuss1, Cynthia S. Garvan1, Stephen J. Blackband1
1University of Florida, Gainesville, Florida, USA

Diffusion tensor MRI was used in a blinded study to investigate white matter changes in a population of 10-11 years old children with and without prenatal cocaine exposure. Left and right frontal medial callosal white matter fibers showed a statistically significant reduction in fractional anisotropy (FA) in children exposed to cocaine during prenatal development (P < 0.05). Additional white matter regions studied showed trends towards decreased FA. These preliminary results suggest prenatal cocaine exposure induces microstructural changes in frontal white matter.

12:06 340. Age Related Cognitive Decline and Regionally Specific Changes In White Matter Integrity
Rebecca Ann Charlton1, Thomas Richard Barrick1, Michael O'Sullivan1, Christopher Andrew Clark1, Robin G. Morris2, Hugh S. Markus1
1St George's Hospital Medical School, London, UK; 2Institute of Psychiatry, London, UK

The brain mechanisms for age related decline in cognitive abilities remains poorly understood. It has been suggested that grey matter atrophy leads to cognitive decline, but a number of recent post-mortem studies do not support this hypothesis. There is growing evidence for age related reduction in white matter structural integrity, this in turn predicting cognitive decline. Using diffusion tensor imaging (DTI) we investigated white matter changes in ageing, and the relationship between these changes and cognitive decline. White matter degeneration was apparent with increasing age, and a significant relationship was apparent between white matter changes and cognitive function.

12:18 341. Comparing Microstructural and Macrostructural Human Cortical Development: DTI vs. Gyri
Amy delPoiy1, Pratik Mukherjee1, Roland G. Henry1, Savannah C. Partridge1, Srivaths Veeraraghavan1, Hua Jin1, Ying Lu1, Steven P. Miller1, Donna M. Ferriero1, Daniel B. Vigneron1, A. James Barkovich1
1University of California, San Francisco, California, USA

We studied the macrostructural and microstructural brain development of premature infants to identify reliable assays of cortical maturation. We used 3D volumetric imaging to score gyral development quantitatively in a consistent plane, and diffusion tensor imaging (DTI) to study microstructural cortical changes. We found that gyration score, diffusion anisotropy, and radial diffusivity correlate with age and with each other. However, diffusion anisotropy and radial diffusivity did not correlate with gyration independent of their common association with age, confirming that DTI provides microstructural information about cortical development in premature newborns not available from the gross morphology of gyration.
Novel Reconstruction Methods

Sakura 10:30 - 12:30 Chairs: Zhi-Pei Liang and Peter Börnert

10:30 342. Reconstruction of Undersampled Dynamic Images Based on Time Frame Registration

Pablo Irazaval\textsuperscript{1}, Redha Boubertakh\textsuperscript{2}, Jeffrey Tsao\textsuperscript{1}, Reza Razavi\textsuperscript{1}, Derek Hill\textsuperscript{1}
\textsuperscript{1}Universidad Catolica de Chile, Santiago, Chile; \textsuperscript{2}King's College London, London, UK; \textsuperscript{3}ETH and University of Zurich, Zurich, Switzerland

We propose a method for reconstructing under-sampled k-space data that takes advantage of the information redundancy in dynamic cardiac images. From averages of the frames with little motion we predict un-blurred images for frames with large motion (using registration, a la MPEG), while ensuring consistency with the sampled data. We tried this method in 2D cardiac images with an under-sampling factor of five. The reconstructed images show no aliasing while preserving edge information in space and time. This method is applicable to non-cartesian k-space sampling and it does not require the motion to be spatially localized.

10:42 343. Dynamic Images Reconstruction using $kt$-BLAST without Training Data

Redha Boubertakh\textsuperscript{1}, Pablo Irazaval\textsuperscript{2}, Derek L. Hill\textsuperscript{1}, Jo Hajnal\textsuperscript{3}, Simon Arridge\textsuperscript{4}, Reza Razavi\textsuperscript{1}
\textsuperscript{1}King's College London, London, UK; \textsuperscript{2}Universidad Catolica de Chile, Santiago, Chile; \textsuperscript{3}Hammersmith Hospital, Imperial College London, London, UK; \textsuperscript{4}University College London, London, UK

$kt$-BLAST considerably speeds up the acquisition in dynamic cardiac imaging by undersampling the k-space. In order to remove the aliasing from the reconstructed images, this technique needs to learn the spatiotemporal correlations between the acquired data by performing an additional scan. We show on a simulated $kr$ scan that using the sliding window interpolation as a training data set allows to reconstruct a cine that is visually as good as using the acquired training data, without noticeable aliasing artefacts. This opens the way to self-trained $kr$ reconstruction and a further reduction in the total scan time.

10:54 344. Temporal Filter Design for Time-Resolved VIPR Using an Iterative Density Compensation Algorithm

Jing Liu\textsuperscript{1}, Aiming Lu\textsuperscript{1}, Andrew Alexander\textsuperscript{1}, James G. Pipe\textsuperscript{2}, Ethan K. Brodsky\textsuperscript{1}, Derek Seeber\textsuperscript{1}, Thomas M. Griss\textsuperscript{1}, Walter F. Block\textsuperscript{1}
\textsuperscript{1}University of Wisconsin-Madison, Madison, Wisconsin, USA; \textsuperscript{2}Barrow Neurological Institute, Phoenix, Arizona, USA; \textsuperscript{3}IGC Medical Advances Inc, Milwaukee, Wisconsin, USA

Temporal filters for sliding window reconstruction in 3D PR can exploit the variation in the trajectory sampling density to generate time-resolved image volumes that indicate the general flow patterns while reducing the penalty for undersampling. The filter design and the corresponding data density compensation, which determine the tradeoff between SNR and temporal resolution, have only been examined empirically to date. We modify a method originally applied to PROPELLER diffusion imaging to determine the density compensation and apply it to time-resolved contrast enhanced MR angiography studies. We demonstrate a significant reduction in undersampling artifact in patient exams.

11:06 345. Robust Field Map Estimation in a Dixon Water-Fat Separation Algorithm with Short Echo Time Increments

Huanzhou Yu\textsuperscript{1}, Scott B. Reeder\textsuperscript{1}, Ann Shimakawa\textsuperscript{1}, Jean H. Brittain\textsuperscript{1}, Norbert J. Pelc\textsuperscript{1}
\textsuperscript{1}Stanford University, Stanford, California, USA; \textsuperscript{2}GE Medical Systems, Menlo Park, California, USA

For the “Dixon” water-fat separation technique, if the echo shift is not chosen conventionally as multiples of $\pi$, it has been shown that an iterative method can be used to estimate the field map, thereby water and fat can be calculated with the field map corrected signals. However, there is intrinsic ambiguity in estimating the field map. We propose a robust field map estimation scheme by a region-growing algorithm with the guidance from low-resolution Dixon reconstruction. Reconstruction of 18 “Dixon” data sets is performed, and shows that the robust method increases the separation's immunity to field inhomogeneity.

11:18 346. Partial Fourier Spiral Reconstruction under Consideration of Off-resonance Effects

Hisamoto Moriguchi\textsuperscript{1}, Jonathan S. Lewin\textsuperscript{1}, Jeffrey L. Duerk\textsuperscript{1}
\textsuperscript{1}University Hospitals of Cleveland / Case Western Reserve University, Cleveland, Ohio, USA

Partial Fourier Spiral Reconstruction (PFSR) algorithm has recently been proposed as an efficient reconstruction technique for partially acquired spiral data. In this technique, iterative procedures are performed after k-space data are distributed to a large rescaled matrix. In the previous study, phase constraint (PC) is imposed on the image at each iteration. However, the results depend on the accuracy of the estimated phase map. In this study, it is shown the image reconstructed with extended finite-support constraint (EFSC) leads to significant improvement from that with PC particularly when off-resonance blurring artifact correction is performed.
11:30  347.  Efficient Iterative Reconstruction for MRI in Strongly Inhomogeneous \(B_0\)

Christoph Barmet\(^1\), Jeffrey Tsao\(^1\), Klaas P. Pruessmann\(^1\)
\(^1\)ETH Zürich, Zürich, Switzerland

An efficient iterative procedure is proposed for image reconstruction in the presence of substantial \(B_0\) inhomogeneity. Based on the cg algorithm, the method optimizes the spatial response function along with the resulting noise level. Feasibility is demonstrated by imaging experiments in the presence of strong externally induced \(B_0\) variation.

11:42  348.  Iterative \(\Delta B_0\) and \(T_2^*\) Correction for Radial Multi-Gradient-Echo Imaging

Holger Eggers\(^2\), Peter Boesiger\(^2\)
\(^1\)Philips Research Laboratories, Hamburg, Germany; \(^2\)University and ETH Zurich, Zurich, Switzerland

An iterative correction of off-resonance and relaxation artifacts based on \(\Delta B_0\) and \(T_2^*\) maps is investigated regarding its ability to improve image quality in radial multi-gradient-echo imaging. In contrast to previously proposed direct approaches, it is shown to achieve an almost complete suppression of these artifacts in simulations. Moreover, the image quality is demonstrated to primarily depend on the resolution of the maps. The availability of additional information on the spatial distribution of \(\Delta B_0\) and \(T_2^*\), for instance from a separate reference scan, therefore appears essential to permit the use of longer echo trains in radial multi-gradient echo imaging.

11:54  349.  Compensating for Within-Voxel Susceptibility Gradients in BOLD fMRI

Bradley P. Sutton\(^1\), Douglas C. Noll\(^2\), Jeffrey A. Fessler\(^2\)
\(^1\)Beckman Institute, Urbana, Illinois, USA; \(^2\)University of Michigan, Ann Arbor, Michigan, USA

High field strengths and single-shot acquisitions are used for fMRI studies, sensitizing these acquisitions to both the BOLD effect and to field inhomogeneities due to susceptibility differences at air/tissue interfaces. Conjugate phase and iterative methods have been used to correct for the resulting image distortions, but these methods do not address susceptibility-induced signal losses. Two methods are presented which reduce the amount of signal dropout; one method uses a piece-wise linear model for the local resonant frequency within each voxel, the other method uses an oversampled field map and a corresponding piecewise constant model within each voxel.

12:06  350.  MRI Image Reconstruction by Polar Fourier Transform

Hua Guo\(^1\), Allen W. Song\(^1\)
\(^1\)Duke University, Durham, North Carolina, USA

Polar Fourier Transform (PFT) has been used for applications in which data is sampled on polar grids. However, it has not seen wide use in MRI because most of the images are acquired in Cartesian coordinates. For k-space data sampled on non-Cartesian grids, such as those using radial and spiral sampling schemes, PFT may provide a simple expression for image reconstruction. We demonstrate, in this report, using k-space data sampled concentrically over polar grids, the advantage of using PFT for image reconstruction to achieve low estimation error. A lookup table can be incorporated to drastically reduce the computation time.

12:18  351.  Image Reconstruction in Magnetic Resonance Diffractive Imaging Technique

Satoshi Ito\(^1\), Yoshifumi Yamada\(^1\)
\(^1\)Utsunomiya University, Utsunomiya, Tochigi, Japan

A new approach to MR angiography, the NMR diffractive imaging technique, has been investigated. The expression of NMR signals obtained in that technique is similar to the equation for Fresnel diffraction in light waves. Therefore, it is possible to reconstruct images focusing on optional plane in the depth direction using the data scanned two-dimensionally. Since blurred image components out of focal-plane are superimposed on the focal-plane image, we have developed a new algorithm by which blurred image components are effectively removed. These studies demonstrate the possibility of the proposed method as a fast imaging technique for MR angiography.

Modeling Human Abdominal Disease

Annex 2  10:30 - 12:30  Chairs: Uwe Himmelsreich and Dieter Leibfritz

10:30  352.  MRI Characterization of Kidney Lesions in Tuberous Sclerosis Mouse Model

Yanping Sun\(^1\), Sameer Doshi\(^1\), LaiFong Lee\(^1\), Paul Sudenas\(^1\), Brian Donohue\(^1\), Kirsten Asrican\(^1\), Aelaf Worku\(^1\), Victoria Walker\(^1\), Nisreen EL Hashemite\(^1\), Alan Lader\(^1\), Hiroaki Onda\(^1\), Hongbing Zhang\(^1\), Mitchell S. Albert\(^1\), Ferenc Jolesz\(^1\), David J. Kwiatkowski\(^1\), Sandra L. Dabora\(^1\)
\(^1\)Brigham and Women's Hospital, Boston, Massachusetts, USA

The conventional Tsc2+/- mouse model is the best model for renal disease as the majority of animals develop kidney cystadenomas by the age of 9-12 months. The physiological features of this model at the cellular and sub-cellular level have not, however, been well characterized by MRI. In this study, we used various MRI methods to identify the different lesions and measured the T1 and T2 characteristics of tuberous sclerosis complex disease in mouse kidney model.
**Micro-MRI Methods with 3D-FIESTA to Detect Renal Micro-Cysts in Chronic Renal Failure Model Mice**

Hisataka Kobayashi, Satomi Kawamoto, Martin W. Brechbiel, Sang-Kyung Jo, Xuwen Hu, Tianxin Yang, Bhalchandra A. Diwan, Thomas A. Waldmann, Jurgen Schnemann, Peter L. Choyke, Robert A. Star

1National Institutes of Health, Bethesda, Maryland, USA; 2Johns Hopkins University, Baltimore, Maryland, USA; 3National Institutes of Health, Frederick, Maryland, USA

Mouse models of disease are powerful tools to analyze the molecular basis of disease. We evaluated if micro-MRI employing a new 3D-MR hydrography signal sequence [3D-fast imaging employing steady-state acquisition (3D-FIESTA)] can visualize chronic cystic changes without contrast enhancement. We were able to positively depict multiple renal cortical cysts of ~0.2 mm diameter in sickle cell transgenic mice and observe serial changes of renal cysts in cyclooxygenase-2 knockout mice during a 2.5 month period. We found that some cysts decreased in size over time. Micro-MRI with 3D-FIESTA can depict and monitor cyst formation in the diseased kidneys of living mice.

**Functional MRI Demonstrates Dynamic Alteration in Renal Glomerular Filtration Rate Following Angiotensin Converting Enzyme Inhibition**

Sara K. Alford, Orhan Unal, Daniel W. Constigny, Frank R. Korosec, Thomas M. Grist

1University of Wisconsin - Madison, Madison, Wisconsin, USA

A MR method to determine skGFR has been developed and used to diagnose renal artery stenosis (RAS). However, the dynamic alterations in renal physiology following ACE inhibition have not been demonstrated non-invasively. The objective of this study is to investigate the acute physiologic effects of ACE inhibition on renal filtration in swine with RAS. Five swine with a surgically implanted stenosis in the renal artery were imaged over 45 minutes. Renal blood flow, extraction fraction and skGFR were calculated. An acute change in skGFR was observed at fifteen minutes in animals with hemodynamically significant RAS.

**Inter-Organ Metabolism in Hepatic Encephalopathy Due to Acute Liver Failure**

Claudia Zwingmann, Nicolas Chatauret, Roger Butterworth, Dieter Leibfritz

1University of Bremen, Bremen, Germany; 2Hospital Saint-Luc (CHUM), Montreal, Quebec, Canada

Acute liver failure (ALF) leads to multiorgan dysfunction and brain edema as the main cause of death. The present study was undertaken to obtain insight into ammonia detoxification and inter-organ metabolism in relation to the progression of experimental ALF. 13C-NMR studies challenged the view that the osmotic effect of astrocytic glutamine accumulation is responsible for brain edema and suggests disturbed energy-metabolism. Hypothermia, which protects against brain edema, prevents mitochondrial dysfunction and accumulation of lactate, but not of glutamine. Distinct metabolic alterations were observed in peripheral organs. In particular, the muscle becomes the major organ responsible for ammonia removal in ALF.

**Mice Liver Metabolism and Defence Mechanisms under Oxidative Stress-Related Conditions: Hypotaurine as Selective Hepatic Antioxidant?**

Claudia Zwingmann, Chantal Éthier, Dieter Leibfritz, Marc Bilodeau

1Hospital Saint-Luc (CHUM), Montreal, Quebec, Canada; 2University of Bremen, Bremen, Germany

The present study investigated if liver injuries associated with oxidative stress and/or apoptosis are accompanied by changes in energy metabolism. Using multinuclear NMR spectroscopy diverse oxidative stress-associated metabolic events were observed in mice liver. Furthermore, early modifications of glucose-metabolism and subsequent energy depletion might trigger death receptor engagement and render the liver cells more susceptible to apoptosis, respectively. N-acetyl-cysteine, which is believed to exert its beneficial effect by replenishment of the antioxidant glutathione, caused several other alterations in mice liver energy- and cysteine metabolism. In particular, the formation of hypotaurine may represent a further antioxidant defence mechanism in the liver.

**MRI as a Novel Tool for Monitoring Liver Hemodynamics**

Hila Harel, Eitan Gross, Gadi Spira, Idit Matot, Eithan Galun, Israel Vlodavsky, Rinat Abramovitch

1Hadassah University Hospital, Jerusalem, Israel; 2Technion, Haifa, Israel

Currently, there are limited tools for monitoring pathological changes in the liver, such as in regeneration or cirrhosis and they are mainly invasive or ex-vivo. Previously, we have demonstrated that changes in oxygen saturation, blood volume and blood flow can be detected by MRI using BOLD contrast. The aim of this study was to implement this method for monitoring the liver non-invasively. We were able to demonstrate changes in blood flow and liver perfusion. In summary, this MRI method is a new and non-invasive tool for following morphological and hemodynamical changes that occur in the liver during regeneration and cirrhosis.
11:42  358.  **MR Microscopy of Pancreatic Islets of Langerhans**

*Samuel Colles Grant*, Nicholas E. Simpson, Stephen John Blackband, Ioannis Constantinidis

1University of Florida, Gainesville, Florida, USA

This report details the first magnetic resonance imaging of the human pancreatic islets of Langerhans. Through the application of ultra-high magnetic fields (17.6 T) and radio frequency microcoils, MR microimages of isolated islets encapsulated in alginate microbeads were achieved at isotropic resolutions of 9.4 mm. These images utilized several MR contrast mechanisms (T2, T2* and diffusion) to display significant heterogeneity within the human islet, which is hypothesized to correspond to either individual cells or cell clusters of the endocrine pancreas.

11:54  359.  **Novel Calibration of in Vivo Body Composition Analysis by 1H MR-Relaxometry**

*Basil Künnecke*, Markus von Kienlin

1F. Hoffmann-La Roche Ltd, Basel, Switzerland

Recently, MR-relaxometry has been introduced for rapid and non-invasive body composition analysis in awake mice and rats. Here, we provide two independent calibration procedures in order to render MR-relaxometry fully quantitative in absolute terms. The lean mass-to-water ratio (1.39±0.03) and the proton density of fat (8.9±0.2 g/mol) required for calibration were determined from statistical analysis of cross-sectional data. Fat composition analysis by in vivo 1C-MRS corroborated these findings and yielded ancillary information on the average chain length (16.3±1.6) and fractional contributions of saturated (27±3%), mono- (22±2%) and polyunsaturated (51±3%) acyl chains in fat.

12:06  360.  **Ghrelin, Hyperphagia and Adipose Tissue Content and Distribution**

*Alison M. Wren*, E Louise Thomas, Caroline J. Small, Caroline R. Abbot, Robert Goodlad

1Hammersmith Hospital, Imperial College London, London, UK

Ghrelin, a circulating gastric hormone, is known to stimulate food intake in rodents and humans. We investigated the effect of chronic subcutaneous ghrelin on adipose tissue content and distribution in wistar rats, using MRI. We have shown that ghrelin-treated rats were hyperphagic and gained more weight than saline-treated. Freely-fed ghrelin treated rats had significantly increased total and visceral adipose tissue volume (p<0.05), whilst ghrelin pair-fed rats had significantly increased visceral adipose tissue volume. These differences were unaltered by correction for total body weight. Thus ghrelin appears to favour adipose tissue deposition independently from its effect on food intake.

12:18  361.  **MRI Assessment of the Growth Effects of Anabolic Steroids in Guinea Pig Model**

*Ed X. Wu*, Haiying Tang, Joseph R. Vasselli

1Columbia University College of Physicians & Surgeons, New York, USA; 2Columbia University, New York, USA

An MRI acquisition and analysis protocol was established and validated for quantitatively investigating the effects of anabolic steroids on muscle growth and body composition in a guinea pig model. Highly significant differences in muscle and organ growth were detected between intact and castrated groups in a 16-wk nandrolone and testosterone treatment protocol, indicating the viability of employing such protocol to assess other potential anabolic steroids in the future. MRI measurements appear more sensitive to potential differences in muscle growth than the dissection study, and offer the ability to assess growth at multiple time points in the same set of animals.

**Cerebral Vascular Imaging Methodology**

**Room D  10:30 - 12:30**  
Chairs: Leif Østergaard and Weili Lin

10:30  362.  **Interleaved Dual-Echo Spiral-Out-Spiral-In DSC Imaging With Generalized SENSE**

*Roland Bammer*, Michael E. Moseley

1Stanford University, Stanford, California, USA

T2*-driven dynamic susceptibility contrast (DSC)-based PWI using single-shot EPI readout is often challenged by technical difficulties. Here, we propose an interleaved dual-echo spiral-out-spiral-in approach combined with generalized SENSE (GSENSE) that provides significantly improved image quality, better spatial resolution, and, hence, better vessel conspicuity at whole brain coverage. These improvements allow one to perform more reliable measurements of the AIF, while still being sufficiently sensitive to small T2*-changes in white matter. In addition, quantitative $\Delta R2^*$-maps, calculated from the two echoes, enables us to correct for T1-effects.
Local Arterial Input Functions based on Vascular Territories

Soren Christensen1, Ona Wu2, Niels Hjort1, Kim Mouridsen1, Christian Gottrup1, Jens Fiehler1, Joachim Röther1, Leif Østergaard1
1Århus University Hospital, Århus, Denmark; 2University Medical Center Utrecht, Utrecht, Netherlands; 3Hamburg-Eppendorf, Hamburg, Germany

We present a method to determine vascular territory specific local arterial input functions (AIFs) in perfusion weighted MRI. The standard SVD method is sensitive to delays and dispersion, causing flow underestimation and possibly overestimation of tissue-at-risk; these problems are accounted for when using local AIF. The local AIFs were selected from the main territories and weighted averages were calculated in watershed zones to mimic dual/triple territory supply in these areas. The proposed method is compared to existing methods on a selection of stroke patients and preliminary findings suggest an increased specificity in delineating areas with high MTT.

Minimizing Macro Vessel Signal in Hemodynamic Parameter Maps Using Independent Component Analysis

Gernot Reishofer1, Franz Fazekas1, Stephen Keeling2, Rudolf Stollberger1
1Graz Medical University, Graz, Styria, Austria; 2Graz University, Graz, Styria, Austria

DCE-MRI is a widely used technique to obtain cerebral hemodynamic parameter maps like CBV, CBF and MTT. Those parameter maps often suffer from the high signal intensity in macro vessels. In this work we present a method for minimising the influence of macro vessel signal using Independent Component Analysis (ICA). These method was applied on multi-shot-EPI data of 23 stroke patients. Reduction of macro vessel signals in the dynamic image series does not affects the signal intensity from the parenchyma. Evaluated parameter maps from the corrected dynamic scan showed better details and a more reliable characterisation of the underlying pathology.

Comparison of CBF Deconvolution Techniques using Bolus Tracking in the Presence of Delayed Tracer Arrival in Acute Stroke Patients

Ona Wu1, Walter J. Koroshetz2, Hakan Ay3, Joannie O'Donnell2, Thomas Benner2, Leif Østergaard1, Chloë J. Lopez2, Ming Wang Zhu2, Rick M. Dijkhuizen1, Bruce R. Rosen2, A. Gregory Sorensen2
1University Medical Center Utrecht, Utrecht, Netherlands; 2Massachusetts General Hospital, Boston, Massachusetts, USA; 3Århus University Hospital, Århus, Denmark

CBF was calculated in acute stroke patients (n=26) (< 12 h) using two deconvolution algorithms. One technique using a standard de-convolution algorithm, singular value decomposition (SVD) is known to be sensitive to delayed tracer arrival. The second technique using SVD with a block-circulant matrix has been shown to be delay insensitive in numerical simulations (cSVD). CBF values were evaluated in tissue that exhibited delayed flow that became infarcted or did not. SVD showed no statistical difference in CBF values while cSVD did (p<.05). These results suggest that delay-insensitive techniques may provide improved insight into tissue salvagability.

Absolute Quantification of Cerebral Perfusion Parameters: Volunteers Examined by Dynamic Susceptibility Contrast MRI and SPECT During Normal Breathing and Hyperventilation

Ronnie Wirestam1, Erik Ryding1, Peter Reinstrup1, Tomas Ohlsson1, Freddy Stålberg1, Stig Holås1
1Lund University, Lund, Sweden; 2Lund University Hospital, Lund, Sweden

Estimates of CBV obtained by dynamic susceptibility contrast (DSC) MRI and SPECT (Tc-99m-labelled red blood cells) were compared in eight volunteers examined during normal breathing and hyperventilation. Average whole-brain DSC-MRI-based CBV was 7.5 ml/(100g) during normal breathing and 6.0 ml/100g during hyperventilation. Using SPECT, the corresponding values were 4.1 and 3.3 ml/(100g), respectively. DSC-MRI-based average CBV values were 73 ml/min/100g (normal conditions) and 52 ml/(100g) (hyperventilation). DSC-MRI-based CBV and CBF decreased during hyperventilation in all volunteers. The correlation between the two modalities was reasonable (r=0.69), and the relative CBV decrease during hyperventilation was almost identical for DSC-MRI and SPECT.

Voxel-Based Group Analysis of Perfusion Images

Renate Gruner1, Karsten Specht1, Lars Esrland1, Gunnar Moen1
1University of Bergen, Bergen, Norway; 2Research Center Julich, Julich, Germany; 3Haukeland University Hospital, Bergen, Norway

A procedure for group analysis of dynamic contrast enhanced perfusion measurements is presented. The procedure identifies group differences by statistically comparing perfusion parametric maps, like blood flow, blood volume and mean transit time, on a voxel-by-voxel basis. Preliminary results from a selection of former professional deep-sea divers are presented. The results indicate predilection of flow disturbances in certain areas in the brain of divers. Similar cluster regions were independently found in blood volume comparison. These preliminary results suggest that the proposed method is a valuable tool when applied to parametric maps in perfusion group analysis.
11:42  368. **A Signal Processing Model for Arterial Spin Labeling Perfusion fMRI**  
*Thomas T. Liu*, *Eric C. Wong*  
1University of California, San Diego, La Jolla, California, USA

In perfusion fMRI using arterial spin labeling (ASL), an estimate of the perfusion time series is formed from the filtered subtraction of interleaved control and tag images. Recent experimental and simulation studies have shown that the choice of subtraction filter affects both the degree of BOLD contamination of the perfusion signal and the extent to which the subtraction process whitens the 1/f noise commonly seen in fMRI data. We present here a model of the ASL signal processing chain that provides an analytical description of the effect of the subtraction filter on BOLD contamination and noise whitening.

11:54  369. **Ramped RF Excitation in 3D TOF MR Angiography at High Magnetic Field**  
*Amir Eissa*, *Alan H. Wilman*  
1University of Alberta, Edmonton, Alberta, Canada

3D TOF MRA often makes use of a ramped RF excitation pulse. At higher magnetic fields (3 T and greater), the actual RF excitation profile as seen by blood will depend not only on the blood’s pathway and on the applied RF pulse, but also on the effects of the RF profile distortion from high field. This can lead to reduced visualization for the distal middle cerebral arteries near the edge of the head. In this study, we investigate the effect of the transverse RF profile variation at 3T on the shape of the RF ramped excitation.

12:06  370. **Dynamic Angiography of the Circle of Willis by Arterial Spin Tagging**  
*Matthias van Osch*, *Jeroen Hendrikse*, *Xavier Goly*, *Chris Bakker*, *Jeroen van der Grond*  
1University Medical Center Utrecht, Utrecht, Netherlands; 2National Neuroscience Institute, Singapore, Singapore

The Circle of Willis plays an important role in providing sufficient blood flow to the brain. By means of arterial spin tagging combined with the Look-Locker technique, the passage of blood through the Circle of Willis can be imaged and viewed dynamically. By calculating the time of arrival, a 2D summary image can be obtained. Additionally, dynamic angiography offers the possibility of quantitative flow measurements in small vessels, unhindered by partial volume effects. This technique was tested in a phantom showing a high linear relation with the true flow. Measurements in healthy volunteers showed agreement with PC flow values.

12:18  371. **Application of Restore Pulse for Improved Intracranial Black Blood Angiography**  
*Eugene G. Kholmovski*, *Seong-Eun Kim*, *Dennis L. Parker*  
1University of Utah, Salt Lake City, Utah, USA

To achieve optimal contrast between vessels and the surrounding tissues in intracranial black blood 3D FSE-MRA, blood signal should be completely suppressed and the surrounding tissues signal maximized. The first requirement is easily achievable, but to completely satisfy the second requirement the TR of the pulse sequence should be very long to allow CSF magnetization recovery. Such a long TR results in unacceptable long scan time. Application of FSE with -90 degree restore pulse to speedup CSF magnetization recovery and improve vessel/tissue contrast in intracranial black blood angiography is studied.

### Catheter Tracking and Cardiovascular Intervention

**Room B-1  10:30 - 12:30**

10:30  372. **Interventional MRA With No Strings Attached: Wireless Active Catheter Visualization**  
*Harald H. Quick*, *Michael O. Zenge*, *Hilmar Kuehl*, *Gernot Kaiser*, *Stephanie Aker*, *Silke Bosk*, *Joerg F. Debatin*, *Mark E. Ladd*  
1University Hospital Essen, Essen, Germany; 2Siemens Medical Solutions, Erlangen, Germany; 3University Hospital Hamburg, Hamburg, Germany

RF resonators that inductively couple their signal to MR surface coils were implemented into catheters to enable wireless active instrument visualization. Instrument to background CNR was systematically investigated as a function of the excitation flip angle. In vivo evaluation of the instruments was performed in interventional MRA procedures on five pigs under MR guidance. Cartesian and projection reconstruction TrueFISP imaging enabled simultaneous visualization of the instruments and vascular morphology in real-time. The implementation of RF resonators enabled robust visualization of the catheter curvature to the very tip. Additionally, due to inductive signal coupling, no wire connection compromises instrument handling.

10:42  373. **Radial Acquisitions with Real-Time Tracking and Adaptive Imaging Parameters**  
*Daniel Robert Elgort*, *Claudia Hillenbrand*, *Eddy Wong*, *Shaoxiong Zhang*, *Frank Wacker*, *Jonathan Lewin*, *Jeffrey Duerk*  
1Case Western Reserve University, Cleveland, Ohio, USA; 2University Hospitals of Cleveland, Cleveland, Ohio, USA

MR catheter tracking and adaptive image parameter systems have been developed to facilitate image-guided cardiovascular interventions. The tracking provides real-time images that follow the device as it is moved though the vascular tree. The adaptive parameter software allows the FOV, spatial resolution, temporal resolution, and other image parameters to react, in real-time, to changes in catheter speed so suspicious plaque and other localized pathology can be inspected with greater detail. The current system has been modified to employ radial true-FISP imaging, coupled with high speed radial reconstruction techniques. These developments have made possible significantly increased frame rates and smaller FOVs.
Passive Tracking of a Catheter With Multiple Tuned Fiducial Markers Using Interleaved Sequences
S R. Hegde¹, M E. Miquel¹, R Hobertahk², D Gilderdale², I Young², S F. Keevil², D L. Hill², R S. Razavi²
¹Kings College, London, London, UK; ²Imperial College, London, UK

The current lack of FDA or CE approved MR compatible catheters and guide wires is an important obstacle to clinical MR guided endovascular procedures. To improve upon existing active and passive techniques we propose the use of multiple fiducial coils on standard balloon angiographic catheters along with using interleaved real time and interactive sequences. This allows for delineation of both the catheter tip and it’s length.

Four Dimensional Visualization System for Real-Time Scan Plane and Catheter Navigation
Perry Radau¹, Nick Hu¹, Jeff A. Stainsby¹, Graham A. Wright¹
¹Sunnybrook and Women’s College Health Sciences Centre, Toronto, Ontario, Canada

A challenge of real-time MRI is that selecting scan planes of interest and guiding catheter interventions typically require cognitively solving complex spatial problems to relate 2D images to the 4D (3D + time) beating heart. Visualization software is presented with an intuitive 3D interface that continuously synchronizes the spatial and phase information of the real-time images with a 4D high-resolution prior volume acting as a reference. For interventions requiring precise guidance of a catheter to a target (e.g. endomyocardial grafts) the system provides a 3D catheter and targeting display that utilizes active catheter position information.

Intravascular Parallel Imaging: A Feasibility Study
Claudia M. Hillenbrand¹, Eddy Y. Wong¹, Mark A. Griswold¹, Shaaxiong Zhang¹, Shervin Rafie¹, Jonathan S. Lewin¹, Jeffrey L. Duerk¹
¹University Hospitals of Cleveland, Cleveland, Ohio, USA; ²University of Wuerzburg, Wuerzburg, Germany

We explore the possibility of intravascular parallel imaging using a catheter-based, opposed-solenoid phased array coil. The opposed solenoid phased array was recently introduced as a dual-functional device for combined interventional catheter tracking and high resolution, cross-sectional intravascular imaging. We demonstrate in phantom and swine experiments that this coil design, in combination with partially parallel acquisitions, allows for a third important function in intravascular interventions: rapid, high-resolution survey imaging in planes parallel to the longitudinal axis of the coil. This feature enables quick screening of longer segments of the vessel wall as demonstrated in the abdominal aorta and the vena cava.

Intravascular MR/RF-Enhanced VEGF Gene Therapy of Atherosclerotic In-Stent Restenosis
Fabao Gao¹, Bensheng Qiu¹, Sourav Kar², Xiaoming Yang¹
¹Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Recently, we have developed a new technique of intravascular magnetic resonance (MR)/radiofrequency (RF)-enhanced vascular gene transduction/expression. The present study was to validate this new technique in a more preclinical setting, using intravascular MR-mediated RF heating to enhance vascular endothelial growth factor (VEGF) gene therapy of atherosclerotic in-stent restenosis in pigs.

Percutaneous Balloon Aortic Valvuloplasty Under Real-time MRI Guidance
Shaaxiong Zhang¹, Yiping Chen¹, Shervin Rafie¹, Claudia Hillenbrand¹, Jeffrey L. Duerk¹, Jonathan S. Lewin¹
¹University Hospitals of Cleveland, Case Western Reserve University, Cleveland, Ohio, USA

Percutaneous balloon aortic valvuloplasty (PBAV) has been used as an alternative to surgical valve replacement and to surgical valvulotomy. Similar to other cardiac interventional procedures, PBAV is routinely performed under x-ray fluoroscopy. Over the past few years, MRI has emerged as a potential powerful tool for guiding a variety of cardiovascular interventional procedures. However, the feasibility of conducting PBAV under MR guidance has not been reported. Based on this study, we concluded that it is feasible to perform PBAV under real-time MR guidance using a conventional x-ray balloon catheter.

X-Ray Compatible RF-Coil for MR Imaging
Viola Rieke¹, Arundhuti Ganguly¹, Greig C. Scott¹, Bruce L. Daniel¹, John M. Pauly¹, Rebecca Fahrig¹, Norbert J. Pelc¹, Kim Butts¹
¹Stanford University, Stanford, California, USA

Magnetic resonance imaging and x-ray fluoroscopy are powerful imaging modalities that can be combined in a hybrid system. However, conventional RF-coils located in the path of the x-ray beam can degrade fluoroscopic images and render them useless for image guidance. We constructed a phased array coil with minimal x-ray attenuation by using aluminum as the conductive material and by designing a coil layout without discrete elements in the x-ray FOV. This x-ray compatible coil allows for fluoroscopic image acquisition with minimal or no impact on the x-ray images while maintaining excellent MR image quality.
Wednesday AM

12:06 380. Magnetic Resonance Guided Cardiac Catheterisation in Children and Adults with Congenital Heart Disease
Vivek Muthurangu1, Andrew Taylor2, Sanjeet Hegde1, Marc Miguel1, Derek Hill1, Reza Razavi1
1Kings College London, London, UK; 2Institute of Child Health, London, UK

We describe the first 33 patients who underwent interventional cardiac MR with x-ray back-up. We were able to measure PVR, plan intervention and register x-ray and MR images.

12:18 381. MR Assessment of Carotid Stent Therapy
Alastair Martin1, David Saloner1, Oliver Weber2, Timothy Roberts1, Heidi Roberts1, Bill Dillon1,
Van Halbach1, Chris Dowd1, Randall Higashida1
1University of California - San Francisco, San Francisco, California, USA

MR imaging was performed immediately prior to and following stent placement as therapy for >70% stenosis of the carotid artery. MR angiographic image quality was compared to x-ray techniques and MR was used to assess bulk flow and perfusion changes resulting from the therapy. Further, diffusion and post-contrast turbo-FLAIR imaging were used to detect potential ischemic complications. MR angiography reliably reflected vessel lumen morphology and flow within the stented vessel increased substantially. Perfusion revealed slight ipsilateral shortening of MTT and TTP but no local defects. No acute post-treatment ischemia was detected or clinically evident.

Clinical Cancer MR Spectroscopy: Improved Definition

Room B-2  10:30 - 12:30            Chairs: Carolyn E. Mountford and N.R. Jagannathan

10:30 382. High Resolution Magic Angle Spinning 1H NMR Spectroscopic Analysis of Choline Region in Rat Brain Glioma Undergoing Apoptosis
Piia K. Valonen1, Julian L. Griffin2, Kimmo K. Lehtimäki1, Timo J. Liimatainen1, Olli HJ Gröhn1,
Risto A. Kauppinen3
1University of Kuopio, Kuopio, Finland; 2University of Cambridge, Cambridge, UK; 3University of Manchester, Manchester, UK

High resolution magic angle spinning (HRMAS) 1H NMR spectroscopy was used to study metabolite changes in the choline chemical shift region in a rat glioma during gene therapy–induced apoptosis. HRMAS was able to separate peaks from choline (Chl), glycerophosphocholine (GPC), phosphocholine (PC), taurine (Tau) and myo-inositol (mI), forming the in vivo choline peak. Early phase of apoptosis, prior to drop in cell density, was associated with increase in GPC, PC and mI, while Tau and Chl stayed unchanged. Synchronous cell eradication resulted in a precipitous decline in Tau, yet 1H HRMAS detectable cholines and mI were well preserved.

10:42 383. Investigation of Choline and Ethanolamine Containing Compounds in Human Prostate Tissues by 2D HR-MAS TOCSY
Mark G. Swanson1, Andrew S. Zektzer1, Z. L. Tabatabai1, Jeff Simko1, Lars Schmitt1, Peter R. Carroll1, Daniel B. Vigneron1, John Kurhanewicz1
1University of California, San Francisco, San Francisco, California, USA

A protocol was developed to use 2D high resolution magic angle spinning (HR-MAS) total correlation spectroscopy (TOCSY) to resolve and quantify the individual choline and ethanolamine containing compounds in healthy glandular and malignant prostate tissues in 1 hour. We show that PC/GPC, PE/Eth, total choline/taurine and total ethanolamine/taurine ratios are all significantly higher in prostate cancer vs. healthy glandular tissues. The fast acquisition of 2D TOCSY data on tissues allows overlapping choline and ethanolamine compounds to be resolved and quantified while minimizing metabolic and pathologic degradation to the tissue.

10:54 384. Brain Tumour Classification using Short Echo Time 1H MRS. Objective Comparison of Classification Techniques (LDA, LS-SVM)
Andy Deves1, Lukas Lukas2, Johan A. K. Stekens3, Leentje Vanhamme1, Franklin Arron Howe2,
Carles Majós3, Angel Moreno-Torres3, Marinette van der Graaf2, Anne Rosemary Tate2, Carles Arús2, Sabine Van Huffel1
1KULeuven, Leuven, Belgium; 2St. George’s Hospital Medical School, London, UK; 3CSU de Bellvitge, Barcelona, Spain; 4Unitat Esplugues, Esplugues de Llobregat, Spain; 5University Medical Center Nijmegen, Nijmegen, Netherlands; 6Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain

We present an objective comparison of several techniques for brain tumour classification using short echo time MRS. Linear Discriminant Analysis as classical and Least Squares Support Vector Machines as kernel-based technique reached a similar performance. Also the influence of several factors (normalization method, complete spectra versus selected regions versus peak integrated values) on the performance is tested. Our results indicate that selected regions and peak integrated values can also be used to categorize brain tumours. Comparison between L2- and water normalization yields in a few cases a significantly lower performance for water normalization, but other normalizations must still be investigated.
11:06 385. **Optimal Timing for in Vivo 1H-MR Spectroscopic Imaging of the Human Prostate at 3T**

Tom Scheenen1, Giulio Gambarota1, Elisabeth Weiland1, Dennis Klomp1, Jurgen Füttner2, Jelle Barentsz2, Arend Heerschap1

1University Medical Center Nijmegen, Nijmegen, Netherlands; 2Siemens Medical Solutions, Erlangen, Germany

Theoretical and practical considerations are necessary to optimize the pulse timing for 1H-spectroscopic imaging of the human prostate at 3T. After simulations of the spectral shape of citrate and in vitro measurements three selected spectral shapes were measured in patients with prostate cancer with 2D 1H-MRSI. T1 and T2 relaxation times were estimated for citrate and choline, the two major metabolites of interest in the prostate. Altogether the optimal timing for in vivo MRSI at 3T is an interpulse timing of 90 - 25ms- 180 - 37.5ms- 180 - 12.5ms-echo and a repetition time of 750 ms, which is illustrated with a in vivo 3D MRSI experiment.

11:18 386. **High Resolution 3D MR Spectroscopic Imaging and J-resolved MRS of the Prostate at 3 Tesla**

Daniel B. Vigneron1, Albert Chen1, Charles Cunningham2, Duan Xu1, Ralph Hurd2, Napapon Sailasuta1, John Pauly2, Sarah J. Nelson1, John Kurhanewicz2

1University of California, San Francisco, California, USA; 2Stanford University, Stanford, California, USA; 3GE Medical Systems, Menlo Park, California, USA

MR spectroscopic imaging has become a powerful clinical tool at 1.5T to characterize prostate cancers based on metabolite levels. The goal of this study was to develop 3T prostate MRI techniques to obtain increased SNR, improved spectral and spatial resolution and to investigate the j-modulation of citrate and polyamines at 3T using j-resolved MRS. This study demonstrated the feasibility of obtaining 3D MRSI data from prostate cancer patients at 3T with a 1.87fold increase in SNR and the ability of obtaining high spatial resolution MR spectra throughout the prostate with improved discrimination of choline, creatine and polyamine resonances.

11:30 387. **The Value of 1H MRS in Improving Clinical Assessment for the Diagnosis of Breast Cancer: A Clinical Blind Study at 4 Tesla**

Sina Meisamy1, Patrick J. Bolan1, Ryan Devine1, Ryan Chamberlain1, Frederick Kelez2, Barbara Luikens3, Richard Carlson1, Michael T. Nelson1, Lenore I. Everson1, Timothy Emory1, Douglas Yee1, Michael Garwood1

1University of Minnesota, Minneapolis, Minnesota, USA; 2University of Wisconsin Hospitals and Clinics, Madison, Wisconsin, USA; 3Park Nicollet Medical Center, Minneapolis, Minnesota, USA; 4Fairview South Dale, Minneapolis, Minnesota, USA

The purpose of this study was to evaluate whether the addition of MRS to MRI can improve the accuracy of a clinicians assessment in the diagnosis and management of breast cancer. The results show that when MRS is incorporated to MRI, there is an overall improvement in sensitivity and specificity for diagnosing patients. As a result there is an overall reduction in the number of missed cancers and unnecessary biopsies.

11:42 388. **Specificity of Choline Metabolites for In Vivo MRS Diagnosis of Breast Cancer at 1.5T**

Peter Stanwell1, Laurence Gluch1, David Clark3, Boguslaw Tomaneck2, Luke Baker3, Bruno Giuffre3, Cynthia Lean1, Peter Malycha1, Carolyn Mountford2

1Institute for Magnetic Resonance Research, Sydney, New South Wales, Australia; 2The Breast Centre, Sydney, New South Wales, Australia; 3Institute for Biodiagnostics, Winnipeg, Manitoba, Canada; 4Sydney Adventist Hospital, Sydney, New South Wales, Australia; 5Royal North Shore Hospital, Sydney, New South Wales, Australia

In vivo 1H MRS assessment of the cellular chemistry of breast cancer has not, based on the presence of the composite resonance at 3.2ppm, provided accuracies sufficient for clinical management. Post acquisitional processing of In vivo 1H MR spectra (1.5T) from human breast tissue allows distinction of patients with malignancies from volunteers with a 80% sensitivity and 100% specificity. Resolution of the composite choline into components improves the specificity of the In vivo MRS method but doesn’t overcome the problem of 20% false-negatives. 43 volunteers, including 3 lactating mothers, were compared with 21 breast cancer patients.

11:54 389. **Comparison of MRSI and Image Guided Histopathology in Treatment Naive and Treated Patients with Malignant Glioma**

David Hearshen1, Lisa Scarpace1, Jack Rock1, Jorge Gutierrez1, Joe Blechinger1, Suresh Patel1, Tom Mikkelsen1

1Henry Ford Health System, Detroit, Michigan, USA

Proton MRS has been used to characterize untreated brain tumors, assess response to therapy and evaluate previously treated patients for possible tumor recurrence. Effects of treatment, chemo or radiation, and tumor necrosis may result in voxels containing normal tissue, tumor, and radiation necrosis, complicating comparison with pretreatment MRS. In this study we correlated MRSI with image guided stereotactic biopsies from treatment naive and treated patients to determine if spectral patterns in pure tumor from treatment naive patients correspond to confirmed pure tumor in treated patients. Knowledge of any differences in spectral patterns is important when following patients serially with MRS
3D 1H MRSI, MRI, and Diffusion Tensor Imaging in Newly-Diagnosed Patients with Grade 3 Brain Tumors

Esin Ozturk1, Susan Chang1, Sarah J. Nelson1
1University of California at San Francisco, San Francisco, California, USA

3D 1H Magnetic Resonance Spectroscopic Imaging (MRSI) data, Apparent Diffusion Coefficient (ADC) and Anisotrophy (ANI) maps of newly diagnosed Grade 3 brain tumor patients were analyzed on a voxel by voxel basis to determine their differences and correlation patterns in normal appearing white matter (NAWM), contrast enhancing, T2 hyperintensity excluding contrast enhancing and metabolically active tumor areas. Significant (P<0.05) differences and correlations of spectral and diffusion parameters were found in these regions, and their importance for understanding tumor characteristics were investigated.

Improved Delineation of Brain Tumors: An Automated Method for Segmentation based on Pathologic Changes of 1H-MRSI Metabolites in Gliomas

Andreas Stadlbauer1, Oliver Ganslandt1, Stephan Gruber2, Christopher Nimsky1, Rolf Buslet1, Rudolf Fahlbusch1, Ewald Moser2
1University of Erlangen-Nuremberg, Erlangen, Germany; 2Medical University of Vienna, Vienna, Austria

High-resolution 1H-MRSI was used to investigate changes of Choline (Cho), Creatine (tCr) and N-acetyl-aspartate (NAA) in 10 patients with gliomas. Maps of Cho/NAA-ratios were calculated and automatic segmentation of the tumors was performed. These areas of biochemical changes were compared to hyperintense areas of T2-weighted routine MRI’s. For all the T2w-areas were contained fully in the segmented areas of pathologic metabolism which extended on average by 24%. Biopsies from the MRSI/T2w-difference-areas showed tumor infiltration ranging from 4–17%. We conclude that high-resolution 1H-MRSI in combination with our segmentation-algorithm can improve delineation of tumor borders compared to routine tumor MRI diagnosis.

GOLD CORPORATE MEMBER LUNCHEON SYMPOSIUM
Philips Medical Systems
Breakthrough Applications in MR

Main Hall 12:30 – 13:30

Comparing Functional Connectivity in Normal and Dyslexic Readers with Cluster Analysis using a Continuous Phonological Task

Larissa I. Stanberry1, Dietmar Cordes1, Todd Richards1, Rajesh R. Nandy1, Elizabeth Aylward1, Virginia W. Berninger1
1University of Washington, Seattle, Washington, USA

The present study examined the patterns of functional connectivity among different brain areas in dyslexics and control patients. We used a hierarchical clustering algorithm combined with dendrogram sharpening to investigate temporal correlations across the brain during a continuous phonological task. Normal subjects showed activation in superior temporal (STG), inferior frontal (IFG) and fusiform gyri (FFG), cerebellum and occipital temporal cortex (OTC). Six dyslexic subjects showed decreased activation in STG, IFG, FFG and OTC areas. Interestingly, three of the dyslexic readers had extensive activation in the cerebellum, much larger than that registered for the control readers.

Global Cerebral Asymmetry Correlates with Motor but not Language Laterality

Clare E. Mackay1, Sabrina Cugno2, Matthew D. Robson1, Julie Connell1, Gina M. Clark1, Tim J. Crow1, Neil Roberts2
1University of Oxford, Oxford, UK; 2University of Liverpool, Liverpool, Merseyside, UK

The presence of both global and local structural asymmetries as well as functional laterality in the human brain is well established, but the relationship between them remains unclear. The aim of the present study is twofold; 1) establish a method for calculating functional laterality for a language and a motor paradigm, 2) investigate whether a relationship exists between brain torque and language or motor laterality in 33 healthy right handed subjects. Brain torque correlated with fMRI laterality for right finger tapping (p<0.05) but no language laterality measures. Possibly language laterality is dependent upon local rather than global structural asymmetries.
Neurophysiological response to the visual processing of words, sentences, nonwords and non-sentences in the native vs. second vs. foreign language was examined in twelve healthy right-handed trilingual subjects. Block paradigms (words, sentences, non-words and non-sentences vs. baseline) were used in a 1.5T MR system (Vision, Siemens) with visual cues given through LED goggles. SPM99 was used for post-processing. Activation was predominantly in the language centers (Broca’s area and Wernicke’s area), other than the frontal, occipital lobes and cerebellum. While maximum pre-frontal activation was observed to occur for familiar languages, foreign language processing elicited more activation in the Broca’s area.

The aim of this study was to evaluate three different fMRI paradigms to preoperatively map the speech-eloquent areas. Ten patients with brain tumors were asked to 1) generate verbs fitting to a given substantive (VG), 2) generate words beginning with a given alphabetical character (WG), 3) enumerate months (ME). Preprocessing and statistical analysis was performed using BrainVoyager®, determining position and volume of the activated clusters. The paradigm VG showed the best performance, allowing the robust localization of both Broca’s and Wernicke’s area, and can be recommended for the preoperative mapping of the cortical language representation.

The fMRI study was performed to investigate the differences between visual recognition of known and unknown ideographic characters. A judgment test of the direction of Kanji (known), Seika (unknown) characters and random line drawings was performed. It was suggested that the BA37 may be related to the visual processing to associate the morphology with phonetics or semantics. The junction area of BA22 and BA37 may be involved in the further processing to integrate the recognized visual information with phonetics or semantics. Successful association with semantics and phonetics may reduce the demand for visual recognition of ideographic characters.

An fMRI study was performed to investigate spatial correlates of music listening and spatial-temporal processing. In this study, we investigated spatial correlations of activation while listening to Mozart’s sonata and performing STP tasks. Puzzles were displayed and Mozart Sonata and Beethoven’s Fur Elise were presented to subjects. Results show prefrontal and occipital activation sites common to STP and listening to Mozart’s sonata while Beethoven’s music activated sites only in the temporal lobe.

In an earlier fMRI study, listening to Mozart sonata activated auditory cortex as well as sites in prefrontal and occipital cortices and cerebellum. Prior studies suggest that those areas could be involved in spatial-temporal processing (STP) of information. In this study, we investigated spatial correlations of activation while listening to Mozart’s sonata and performing STP tasks. Puzzles were displayed and Mozart Sonata and Beethoven’s Fur Elise were presented to subjects. Results show prefrontal and occipital activation sites common to STP and listening to Mozart’s sonata while Beethoven’s music activated sites only in the temporal lobe.

Neuroimaging studies have demonstrated activations in the cerebellum to be associated with neocortical activations during verbal working memory (VWM). The present study investigates the functional activation of the cerebro-cerebellar circuitry with increasing memory load and task practice. Both reaction time and functional MRI activation showed significant linear increases with increasing memory load. Load-dependent regions included left inferior frontal, left inferior parietal, bilateral superior cerebellum and right inferior cerebellum. The left inferior parietal and right inferior cerebellum showed significant increases with improved task performance. These results replicate and extend our previous findings of fMRI activation in the cerebellum during VWM.
14:50 400. Working Memory Load Enhances Attention
Loukas G. Astrakas1, Maria K. Zarifi2, Martin H. Teicher2, A Aria Tzika1
1Massachusetts General Hospital and Shriners Institute, Harvard Medical School, Boston, Massachusetts, USA; 2Children's Hospital Boston, Harvard Medical School, Boston, Massachusetts, USA; 3Mclean Hospital, Harvard Medical School, Belmont, Massachusetts, USA

We have modified an earlier proposed simple auditory motor paradigm by increasing the working memory load. We acquired increased signal-to-noise data at 3T as compared to our previous 1.5 T acquisitions in agreement with others. We have been able to detect enhanced attention regions, which we attributed to the increased working memory load. Inasmuch as both attention and working memory are affected in attention deficit, related neuro-developmental or psychiatric disorders, we suggested that our new paradigm can be used as a useful tool for assessing these disorders in the clinical setting.

15:00 401. Functional Localization of Working Memory: Activation Likelihood Estimation of the N-Back Task
Kathryn M. McMillan1, Angela R. Laird2, Richard Castillo3, David C. Glahn2, Jack L. Lancaster2, Peter T. Fox2
1University of Wisconsin, Madison, Wisconsin, USA; 2University of Texas Health Science Center, San Antonio, Texas, USA; 3Trinity University, San Antonio, Texas, USA

There is typically some subject variability in higher-order cognitive tasks, such as working memory. Meta-analyses of these paradigms yield areas of activation that can be used in developing new hypotheses and interpreting results from neurologically abnormal subjects. Activation likelihood estimation (ALE) was employed to perform a quantitative meta-analysis of the n-back task. In addition to a main effects meta-analysis, further meta-analyses were performed by dividing the studies into groups to determine the effect of task variations. Rather than attributing changes in activation patterns to differences in verbal or non-verbal stimuli, these results suggest asymmetries may be due to automation.

15:10 402. A Stimulus Design Allowing Separation of Main and Interaction Effects Applied to a Visual Attention Task
Johan Martijn Jansma1, Peter van Gelderen1, Jacco Adrianus de Zwart1, Masaki Fukunaga1, Peter Kellman1, Jozef H. Duyn1
1National Institutes of Health, Bethesda, Maryland, USA

An event related BOLD fMRI stimulus design is presented that allows the detection of interaction effects between multiple neuronal processes in the presence of non-linearity’s of the BOLD contrast mechanism. The design is applied on the study of attentional modulation effects on activity in the visual cortex at 3.0 T. Results indicate that attention evoked BOLD responses in visual cortex in absence of a stimulus. Measured interaction effects were attributed to neuronal processes rather than byproducts of the BOLD contrast mechanism. The design is applicable to other experiments that require separation of primary and interaction effects of multiple tasks.

15:20 403. Visualization of the Dynamic Neural Activity during the Perception of 3-D Structure from Random Dot Motion: An fMRI-MEG Combined Study
Sunao Iwaki1, Giorgio Bonmassar1, John W. Belliveau1
1Massachusetts General Hospital, Charlestown, Massachusetts, USA

We used both MEG and fMRI measurements to detect dynamic brain responses to 3-D structure perception from random-dot motion. MEG and fMRI signals were measured during subjects viewing the structure-from-motion visual stimuli, in which the coherence of the motion was controlled from 0% (RANDOM) to 100% (SFM). MEG-fMRI combined spatio-temporal imaging technique was used. The bilateral occipito-temporal and the intra-parietal regions showed increased activity in the SFM condition compared to the RANDOM condition 180ms and 240ms after the onset of motion, respectively. These results indicate that these regions play an important role in the perception of 3-D structure from motion.

CLINICAL SCIENCE FOCUS SESSION
Cerebrovascular Diseases and Stroke: Diffusion and Perfusion
Annex 2 13:30 - 15:30 Chairs: Steven Warach and A. Gregory Sorensen

13:30 404. Assessment of Cerebral Perfusion and Oxygenation in Sickle Cell Disease using Arterial Spin Labeling and BOLD MRI
Richard P. Kennan1, Sandra Szuka1, Lenore Ocava1, Henny Bille1, Lawrence Cytryn1, Lennette J. Benjamin1, Ronald L. Nagel1, Mary E. Fabry1
1AECOM, Bronx, New York, USA; 2Jacobi Medical Center, Bronx, New York, USA; 3Montefiore Medical Center, Bronx, New York, USA

Dynamic susceptibility contrast has been used for measuring blood flow and blood volume in SCD, but is difficult to quantify across subjects and is not amenable to routine monitoring in sickle cell patients. ASL and BOLD MRI was used to determine CBF and deoxyhemoglobin in a group of adult sickle cell patients and control subjects. On average, SCD patients had hyperperfusion relative to control subjects while 1 subject had hypoperfusion that correlated with poor performance on neurological examination. These studies establish quantitative CBF levels in uncomplicated adult SCD patients using ASL and enable further studies in higher risk populations.
In patients with neuro-vascular disease, the perfusion reserve capacity is an important predictor for the risk for ischemic events. Transcranial Doppler sonography (TCD) during inhalation of a CO₂-gas-air mixture to determine flow changes in the MCAs is the method most commonly employed clinically. In this study TCD as well as phase contrast MRA measurements of the flow increase during hypercapnia were performed in 15 patients with stenotic disease and compared. An excellent agreement was found between the methods suggesting PC-MRA may be an alternative method for patients with insufficient bone window for TCD.

New techniques have been developed to improve detection of acute-ischemic stroke (AIS) with diffusion-weighted imaging (DWI). These include the use of higher b-values that increase AIS-intensity changes, and FLIPD (a technique that produces cerebrospinal fluid (CSF)-nulled images, in order to minimizes partial-volume effects). This study evaluated which DWI technique [\(b = 1000 \text{ mm}^2\text{s}^{-1}\) or \(b = 1500 \text{ mm}^2\text{s}^{-1}\); or FLIPD-prepared with \(b = 1500 \text{ mm}^2\text{s}^{-1}\)] was most effective in detecting AIS. FLIPD showed a lower sensitivity for detecting AIS. The \(b = 1500 \text{ mm}^2\text{s}^{-1}\) provided no significant improvement over \(b = 1000 \text{ mm}^2\text{s}^{-1}\) DWI.

The purpose of this study was to characterise differences in the temporal evolution of water diffusion parameters of grey and white matter in ischaemic stroke. Thirty-two patients underwent DTI at five different time-points after stroke. Mean diffusivity (D) and fractional anisotropy (FA) were measured in grey and white matter within the lesion and contralateral tissue. The results show significant differences in the evolution of these parameters, with grey matter D recovering faster and FA decreasing more gradually than white matter. Quantification of diffusion parameters after stroke should therefore consider the grey and white matter composition within the infarct.

A major goal of magnetic resonance perfusion-weighted imaging is to identify the tissue at risk of infarction that may be salvaged with treatment in acute ischemic stroke. Studies suggest that gray (GM) and white matter (WM) have different ischemic thresholds. Human MR studies, however, have not assessed this to date. We have applied a novel method2 to derive GM and WM quantitative cerebral blood flow (CBF) values from different ischemic compartments. This study confirms that GM and WM have different ischemic thresholds and suggests that attempts to identify the penumbra via CBF should take tissue type into account.

MRI selection criteria and surrogate outcomes have been hypothesized as means to extend the time window for acute stroke therapy and demonstrate biological activity in Phase II clinical trials. DIAS is a randomized, placebo-controlled double-blind stroke trial using diffusion-perfusion mismatch to select patients for IV thrombolysis > 3 hours from onset and reperfusion as an early marker of therapeutic response. Rates of reperfusion on follow-up imaging performed 4-8 hours post-treatment increased significantly with dose, and rates of clinical recovery at 90 days showed a similar dose response. These results have important implications for the design of future stroke trials.
Optimal Parameter Choice in Predicting Final Outcome in Acute Stroke
Kim Mouridsen, Ona Wu, Walter J. Koroshetz, A. Gregory Sorensen, Leif Østergaard
CFIN, Århus, Denmark; Athinoula A. Martinos Center for Biomedical Imaging, Boston, Massachusetts, USA

PWI and DWI have proven important tools in characterizing the haemodynamic and microstructural changes in brain tissue during acute stroke and may support predicting lesion progression. Due to the increasing number of MRI tissue markers hypothesized to signal infarct risk, there is a growing need for tools that may identify key parameters with high predictive power. We examined the relative importance of various MRI tissue markers using Multivariate Adaptive Regression Splines with special respect to the use of MTT and Flow Heterogeneity (FH). DWI, FH, MTT and CBF are found to be necessary and sufficient in achieving good predictive performance.

Improving the Prediction of Infarct Evolution in Acute Stroke with Diffusion and Bolus Delay
Stephen Rose, Andrew Janka, Mark Griffin, Michael Walsh, James Semple, Jonathan Chalk
University of Queensland, Brisbane, Queensland, Australia; Montreal Neurological Institute, Montreal, Quebec, Canada; GlaxoSmithKline Pharmaceuticals, Cambridge, East Anglia, UK

MRI perfusion measures acquired using the DSC technique have proved useful in identifying ischemic tissue in acute stroke patients. However, theoretical analysis of this technique has shown that significant error in the measure of CBF can occur. In this study we compared the performance of predicting infarct evolution using a tissue classifier algorithm based on DWI, ADC, T2 measures in conjunction with either CBF, MTT or bolus delay corrected perfusion measures (cCBF, cMTT). We found that bolus delay corrected perfusion measures enabled an improved prediction of infarct evolution and evaluation of hemodynamic status of neuronal tissue in acute stroke.

An Atlas for Predicting Stroke Clinical Outcome
Massachusetts General Hospital, Boston, Massachusetts, USA; Kuopio University Hospital, Kuopio, Finland

A fundamental challenge in understanding human brain function is the link between focal damage and its clinical manifestations. We have developed an atlas that quantifies the impact of ischemic damage to a given brain region on outcome as measured by a standard stroke clinical scale. This atlas, which combines lesion location and volume in determining the clinical deficit, was tested in 47 subacute stroke patients. It correlated with stroke severity (r=0.81), a significant improvement over the correlation between clinical outcome and volume alone (r=0.53), suggesting that it can be used to accurately predict clinical outcome following ischemic stroke.

An Integrated Neurovascular XMR Suite for the Clinical Treatment of Acute Stroke and other Neurovascular Diseases
Andrew J M Kiruluta, Pam W. Shaefers, Jim D. Rabinov, Ramon G. Gonzalez
Massachusetts General Hospital, Boston, Massachusetts, USA

We describe a fully functioning interventional XMR suite for the clinical treatment of acute stroke and other neurovascular diseases. To allow for quick and robust patient transport between these two modalities without switching tables, a custom XMR transport system compatible with and capable of interfacing to both a SIGNA MR and an Omega-IV digital subtraction X-ray angiography pedestal with full patient life support and monitoring equipment was designed and installed at MGH. Clinical interventional acute stroke cases combining MR soft tissue contrast with catheter placement under X-ray guidance show promise of improved outcomes.

Cerebrovascular Consequences of Carotid Stenting with and without a Neuroprotection Filter
Iain D. Wilkinson, Sumaria Macdonald, Paul D. Griffiths, Peter A. Gaines, Treveor C. Cleveland, Nikos Papadakis, Kathy Frost, Graham Venables
University of Sheffield, Sheffield, UK; Northern General Hospital, Sheffield, UK

This study monitored the cerebral haemodynamic and parenchymal effects of carotid stenting with and without the placement of an intra-arterial neuroprotective filter. Thirty patients were randomised into protected and unprotected groups and assessed by exogenous perfusion and DWI/ADC maps 24hrs pre-; <3hrs; 24hrs and 1month post-procedure. Changes in hemispheric asymmetry of both transit time and rCBV were evident over time. Focal abnormalities developed on diffusion imaging. There were no significant differences between protected and unprotected patients in measures of hemodynamic status. Significant error in the measure of CBF can occur. In this study we compared the performance of predicting infarct evolution using a tissue classifier algorithm based on DWI, ADC, T2 measures in conjunction with either CBF, MTT or bolus delay corrected perfusion measures (cCBF, cMTT). We found that bolus delay corrected perfusion measures enabled an improved prediction of infarct evolution and evaluation of hemodynamic status of neuronal tissue in acute stroke.

Whole-Brain MR-DSA using Time-Resolved 3D Contrast-Enhanced MRA and Parallel Imaging
Stephan Wetzel, Stephan Meckel, Deniz Bilecen, Ernst Wilhelm Raddi, Klaus Scheffler
Neuroradiology, Basel, Switzerland; Diagnostic Radiology, Basel, Switzerland; MR-Physics, Basel, Switzerland

Time-resolved, contrast-enhanced projection MRA or DSA-MRA has proved to be highly effective to demonstrate neurovascular pathologies that cannot be depicted with alternative MR imaging methods, and has become an important adjunctive diagnostic tool for neurovascular imaging. Besides the lack of volumetric information, 2D projection MRA is hampered by signal cancellations along the thick slab, which in some cases presents a considerable drawback to evaluate the complex intracranial vascular structures. A whole brain, time-resolved volumetric/3D contrast-enhanced MR technique in combination with parallel imaging is presented that offers the possibility to evaluate intracranial vessels with both a high temporal and spatial resolution.
CLINICAL SCIENCE FOCUS SESSION
Novel MR Techniques for Clinical Musculoskeletal Imaging
Room B-1  13:30 - 15:30   Chairs: Joshua M. Farber and William B. Morrison

13:30  416.  Repeatability of a Magnetic Resonance Imaging-Based Method for Measuring Three-Dimensional Patellar Kinematics in Loaded Flexion
Robert Fellows¹, Nicholas Hill², Norma MacIntyre², Mark Harrison³, Randy Ellis¹, David Wilson²
¹Queen's University, Kingston, Ontario, Canada; ²University of British Columbia, Vancouver, British Columbia, Canada

The objective of this study was to determine the repeatability of a new MRI-based technique for measuring patellar tracking at the knee during loaded flexion. In a study of three subjects flexing their knees through a range of loaded flexion for four separate trials, the intrasubject variability of the method was equal to or less than the measurement error found in an accuracy study of the same method using cadaver specimens.

13:40  417.  Magnetic Resonance Imaging Analysis of Patellofemoral and Tibiofemoral Kinematics after Total Knee Arthroplasty
Keh-Yang Lee¹, John P. Slavinsky¹, Michael D. Ries¹, Gabrielle A. Blumenkrantz¹, Sharmila Majumdar¹
¹University of California at San Francisco, San Francisco, California, USA

Total knee arthroplasty (TKA) is a common treatment for severe arthritis and abnormal kinematic patterns have been observed after the surgery. However, the effects of abnormal tibiofemoral kinematics on patellofemoral position were unclear. This study investigated 3D kinematic MRI analysis of TKA joints with newly developed prostheses made of oxidized zirconium. Two significant linear correlations between tibio- and patellofemoral kinematics were observed in our results. These findings suggest that implant designs or surgical techniques which are associated with lateral tibial translation or external tibial rotation may cause lateral patellar tilt or subluxation in TKA.

Yong-min Huh¹, Ho-taek Song¹, Jin-woo Lee¹, Jin-suck Suh¹
¹Yonsei University, College of Medicine, Seoul, Republic of Korea

The purpose of this study was to determine the effectiveness of CE 3D-FSPGR MR imaging in diagnosis of anteromedial soft tissue impingement of the ankle, comparing to routine MR Imaging. Twenty-four patients who had arthroscopically proved anteromedial impingement were enrolled. Thirty control subjects with diagnoses other than impingement were randomly allocated. The overall accuracy for characterizing anteromedial soft tissue impingement was significantly higher (p<0.05) using the CE set (Az = 0.940) than with the routine set (Az = 0.783). CE 3D-FSPGR MR imaging of the ankle is useful in assessing the anteromedial soft tissue impingement, comparing to routine MR imaging.

14:00  419.  Validity of Virtual Arthroscopy made of Fat Suppressed 3D GRE Direct MR Shoulder Arthrography in Determining the Labral Lesion of the Shoulder
Ho-taek Song¹, Yong-min Huh¹, Sung-Jae Kim³, Jin-suck Suh¹
¹Yonsei University, College of Medicine, Seoul, Republic of Korea

The purpose of this study is to evaluate the usefulness of the virtual MR arthroscopy in assessing anterior inferior labral lesion in recurrent shoulder dislocation. We used the fat suppressed axial 3D fast gradient echo sequence for high resolution and contrast in contrast to the conventional 2D imaging. Nineteen patients were studied. Findings were comparable with arthroscopy. Virtual MR arthroscopy of the shoulder joint could be a robust and feasible method for assessing labral pathology in recurrent shoulder dislocation, specifically for investigating Barkart lesion and it would benefit for preoperative surgical planning.

14:10  420.  Accuracy and Limitations of a Quantitative Analysis Method for 3D MRI Data of the Shoulder
Harald Busse¹, Matthias Seiwerts¹, Thomas Kahn¹, Georg von Salis-Soglio¹, Michael Thomas¹
¹Leipzig University Hospital, Leipzig, Germany

The aim was to determine the accuracy and limitations of a novel, quantitative PC-based processing method for 3D MRI scans of the shoulder. Data from 10 healthy subjects in various glenohumeral joint position, in particular the clinically relevant apprehension position were acquired in a vertically open MRI scanner. Surface model objects rendered from the segmented MRI data were available to three observers for further interactive and automatic processing. Despite a limited quality of the underlying model data, a significant difference in the humeral head translation was observed between neutral and apprehension position yielding a posterior and caudal shift on average.
Anterior cruciate ligament tear is more common in female than male athletes. We performed a volumetric analysis of ACL volumes from MR images of 33 males and 30 females. A gender difference in ACL volume was observed (P=0.0025), but there was also a fairly strong correlation with height.

High Resolution MR Arthrography in Patients with Mechanical Symptoms of the Hip: Association with Labral Tears and Cartilage Loss

OBJECTIVE. To determine the association between mechanical symptoms in the hip and labral tears and cartilage loss seen on MR arthrography.

METHODS. 60 patients underwent high-resolution MR arthrography of the hip. Cartilage loss was graded in 5 compartments and compared with arthroscopic findings. RESULTS. The grade (P≤0.01) of cartilage loss (prevalence 75%) and the size (P≤0.02) correlated with the grade of labral tear or the grade of bone marrow edema (P≤0.0175). CONCLUSION. MR arthrography in patients with mechanical symptoms shows frequently labral tears and cartilage loss, and demonstrates a high association of cartilage loss with bone marrow edema.

High-Resolution Ultrashort TE Imaging of the Human Wrist at 3 T

Ultrashort echo-time (UTE) sequences enable the detection of fast-relaxing spin species typically found in tendons, ligaments, and related tissues. Microscopic applications and the requirements for UTE are very demanding on the signal-to-noise ratio (SNR). High-field 2D UTE imaging using radial data acquisition in combination with a four-element surface coil for signal detection has been found applicable to overcome SNR limitations and obtain short TE images of the human wrist at sub-millimeter resolution.

Quantification of DCE-MRI of Knees of Children with JRA: Using an Arterial Input Function Extracted from Popliteal Artery Enhancement

Dynamic Gd-DTPA contrast-enhanced MR imaging (DCE-MRI) was performed on the knees of children with a history of juvenile rheumatoid arthritis (JRA). The contrast enhancement over different regions of interest (ROIs) was quantified based on a two-compartment pharmacokinetic model. In this work a mathematical description for the plasma tracer concentration was extracted from the signal enhancement data obtained from the nearby artery (popliteal) and was used in the model. The kinetic parameters extracted from this model could be used to assess diseases activity and therapeutic response.

A Comparative Study of the Relative Sensitivities of Various MRI Parameters in Measuring Response to Treatment with Infliximab and Methotrexate in Patients with Rheumatoid Arthritis

A number of parameters derived from dynamic contrast enhanced magnetic resonance imaging (DEMRI) have been measured in patients with Rheumatoid arthritis (RA) of the metacarpophalangeal (MCP) joints. During the study patients were treated with either infliximab and methotrexate, or methotrexate alone, measurements were taken at baseline and at 14 weeks. The results show that there is a much greater reduction in synovial inflammation in patients treated with infliximab and methotrexate than methotrexate alone and that the ‘initial rate of enhancement’ (IRE) is the most sensitive DEMRI parameter.

Whole Body-MRI in 160 patients with Musculoskeletal Diseases

The purpose was to evaluate the use of Whole Body-MRI using a multistation coronal Turbo-STIR sequence by using a rolling table platform in the assessment of the extent and distribution of bone marrow involvement and muscle infiltration in patients with musculo-skeletal diseases. Patients with skeletal metastases, bone marrow disorders and muscle inflammation were evaluated by Whole Body-MRI in comparison to the established imaging technique like plane films, skeletal and muscle scintigraphy, Whole Body-FDG-PET. Turbo-STIR Whole Body-MRI is a fast screening and imaging technique for these patients, so Whole Body-MRI is feasible and comparable to these established imaging techniques.
15:20 427. **High Resolution MR Imaging of Trabecular Bone using Steady State Free Precession (SSFP) at 1.5T and 3T**

Suchandrima Banerjee¹, Eric T. Han², Roland Krug³, David C. Newitt¹, Sharmila Majumdar¹

¹University of California San Francisco, San Francisco, California, USA; ²GE Medical Systems, Menlo Park, California, USA

We optimized 3D Fast Imaging Employing Steady State Acquisition (FIESTA), a fully refocused steady state free precession (SSFP) technique, for imaging the micro-architecture of trabecular bone and compared its Signal-to-Noise ratio (SNR) and SNR efficiency to Fast Gradient Echo (FGRE) based on 3D gradient-recalled acquisition in the steady state or GRASS sequence. We imaged eight normal volunteers at 1.5T and 3T and FIESTA images showed significantly higher SNR efficiencies at both field strengths.

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**CLINICAL SCIENCE FOCUS SESSION**

**Digestive Tract MR Imaging**

Room B-2  13:30 - 15:30  Chairs: Thomas C. Lauenstein and David J. Lomas

13:30 428. **Accuracy of MR Cholangiography in the Preoperative Evaluation of Biliary Anatomy in Right-Lobe Living Related Liver Transplantation Donors: Comparison with Intraoperative Cholangiography**

Jae Young Byun¹, Sung Eun Rha², Soon Nam Oh¹

¹Kangnam St. Mary's Hospital, The Catholic University of Korea, Seoul, Republic of Korea

MR cholangiography is useful for evaluating the normal non-dilated bile ductal anatomy in living-donor liver transplantation.


Vivian S. Lee¹, Glenn A. Krinsky¹, Carol A. Nazzaro¹, Jerry S. Chang¹, Jingbo Zhang¹, James S. Babb¹, Jennifer Chalin¹, Glyn Morgan¹, Lewis W. Teperman¹

¹New York University Medical Center, New York, New York, USA

In 108 liver transplant donor candidates, we compared two MR cholangiographic methods for the definition of intrahepatic biliary anatomy—conventional T2-weighted FSE and mangafodipir-enhanced 3D T1-weighted GRE. Combined interpretations were used as a reference standard; 51 also had intraoperative cholangiography. 3D mangafodipir imaging agreed with combined interpretations more often (106/108, 98%) than T2 imaging (89/108, 82%). In those with intraoperative cholangiography, mangafodipir imaging correctly defined anatomy in 48/51 (94%), compared with 43/51 (84%) for T2-weighted imaging. The combination of both techniques correctly identified anatomy in 49/51 (96%), with an 80% sensitivity and 100% specificity for detection of right duct variants.

13:50 430. **High Resolution MRCP with Adaptive Average: Image Quality and Diagnostic Performance**

Evis Sala¹, Victoria L. Jardine¹, Richard T. Black¹, Lucy E. Kershaw¹, Martin J. Graves¹, David J. Lomas¹

¹University of Cambridge and Addenbrooke's Hospital, Cambridge, UK

The diagnostic performance of an interactive MRCP technique with adaptive averaging was assessed prospectively in ten patients. They underwent high-resolution projection imaging using both the conventional and the adaptive interactive sequences. Qualitative visual analysis was performed by two experienced observers in consensus, blinded to the acquisition details. In addition, diagnosis was made by consensus and diagnostic confidence recorded using visual analogue scales. The results demonstrate that adaptive averaging produces a significant improvement in demonstration of peripheral bile ducts compared with the standard technique (p=0.035, one-sided). There was no difference in the diagnostic confidence between the two techniques.

14:00 431. **Volumetric MR Cholangiopancreatography with 3D Turbo Spin Echo and Parallel Acquisition Technique**

Jingbo Zhang¹, Glenn A. Krinsky¹, Vivian S. Lee¹

¹New York University Medical Center, New York, New York, USA

We report a T2-weighted 3D turbo spin echo technique with parallel acquisition that can produce near isotropic (~1 mm) high resolution MRCP images. This technique can be performed within one breathhold or in conjunction with respiratory triggering. Preliminary results show that compared to conventional 2D imaging, 3D volumetric MRCP images rendered by this method have higher quantitative parameters of image quality (signal-to-noise ratio [SNR], contrast-to-noise ratio [CNR] and CNR normalized for voxel size and acquisition times) and advantages of multiplanar and postprocessing capability. Further studies are needed to verify that these improvements translate into improved diagnostic accuracy.
14:10 432. MRCP with the Use of Navigator-Echo Triggering Turbo Spin-Echo: A Comparison with Single Shot
Techniques
Frank Howard Miller1, Charles Fasananti1, Nancy Hammond2, Paul Nikolaidis3, Aqeel Chowdhry1,
Terry Cunningham1, Alto Stemmer2, Wilhelm Horger2
1Northwestern University, Chicago, Illinois, USA; 2Siemens AG Medical Solutions, Erlangen, Germany

This study evaluated Navigator triggering MRCP in the evaluation of the pancreaticobiliary system in comparison with RARE and HASTE techniques. This method showed superior anatomic conspicuity of the biliary and pancreatic ducts with patients able to free breath during the examination. In the future, this technique can replace HASTE and RARE techniques.

14:20 433. Secretin Stimulating MRCP: The Evaluation of a Pancreaticobiliary Reflux
Utaro Motosugi1, Tomoaki Ichikawa1, Tsutomu Araki1, Fumiaki Kitahara1
1University of Yamanashi, Nakakoma, Yamanashi, Japan

The pancreaticobiliary reflux is an important condition as a cause of biliary malignancies. The pancreaticobiliary reflux usually occurs in patients with pancreaticobiliary maljunction. ERCP can evaluate the fine structures of periampullar region morphologically and is the best diagnostic tool for morphological pancreaticobiliary maljunction. But recently pancreaticobiliary reflux was encountered in patients with a normal pancreaticobiliary junction in which pancreaticobiliary reflux was demonstrated by secretin stimulating MRCP. In this study, we investigate the availability of secretin stimulating MRCP for the evaluation of the pancreaticobiliary reflux.

14:30 434. Detection of Bile Flow and Differentiation of Bile Flow Artifact from True Biliary Stone: A Newly-
developed Black-Blood T2-Weighted SE-EPI Imaging
Yuji Watanabe1, Masako Nagayama1, Akira Okumura2, Takashi Tabuchi1, Hideki Mitsu1,
Noriyoshi Morimoto1, Kazuaki Nakada1, Masayuki Kumashiro1, Takashi Kiyono1, Yoshiki Amoh1,
Satoru Nakashita1, Marc Van Cauteren1, Yoshitomo Dodo1
1Kurashiki Central Hospital, Kurashiki, Okayama, Japan; 2Philips Medical Systems, Best, DA, Netherlands

In MR cholangiopancreatography, an artifact from jet flow of bile can be a source of false defect, which resembles biliary stone. It may be very difficult to differentiate such a bile flow artifact from a biliary stone. Newly-developed black-blood T2-weighted SE-EPI images of the biliary tract obtained by applying very low b-factor (b=8) motion-probing-gradient for single-shot SE-EPI sequence makes SE-EPI images very sensitive not only to blood flow of portal or hepatic vein but also bile flow, which facilitates to detect bile flow and to accurately diagnose bile flow artifact.

14:40 435. Gall Bladder and Gastric Dysmotility Shown by EPI in Celiac Disease is Associated with
Abnormalities of 5-HT Metabolism
Luca Marciani1, Nicholas S. Coleman2, Simon P. Dunlop2, Gulzar Singh1, Charles A. Marsden1,
Geoffrey K. Holmes3, Robin C. Spiller2, Penny A. Gowland1
1Sir Peter Mansfield Magnetic Resonance Centre, Nottingham, UK; 2QMC Hospital, Nottingham, UK; 3Medical School, Nottingham, UK; 4Derbyshire Royal Infirmary, Derby, UK

Celiac disease may present with a range of GI symptoms. Circulating levels of serotonin (5-HT) are increased, which may have important effects on GI sensation and motility. Untreated celiac disease is often accompanied by disturbance of gastric emptying, antral motility and gallbladder contraction. EPI showed great promise in monitoring gastric function and can encompass in one single multi-slice volume scan both the gastric lumen and the gallbladder. The aim of this study was to examine gastric and gallbladder motility in untreated celiacs using EPI and to assess, in a separate study, circulating 5-HT levels together with mucosal 5-HT turnover.

14:50 436. Real-Time MR Imaging for the Assessment of Gastric Motility Disorders
Waleed Ajaj1, Susanne C. Goehde1, Roya Jeyrani1, Stefan G. Ruehm1, Gerald Holtmann1, Joerg F. Debatin1, Thomas Lauenstein1
1University Hospital Essen, Essen, Germany

Aim of this study was to evaluate whether patients with increased or decreased gastric motility can be differentiated from healthy volunteers by means of real-time MRI. Each 10 healthy volunteers, ten patients with gastroparesis and ten patients with functional pylorospasm/peptic pyloric stenosis underwent real-time MRI. Antral motility was quantified by calculating a gastric-motility-index (GMI). Patients with gastroparesis showed a lower GMI compared to the volunteers, while the mean GMI of patient with pylorospasm was more than three times as high as the reference value of the volunteers. Hence, real-time MRI is a reliable tool for the assessment of gastric motion.

15:00 437. Evaluation of Activity in Crohn's Disease Using T1-Weighted Dynamic Contrast-Enhanced MRI.
Karl Vincent Embleton1, David A. Nicholson2, Geoff JM Parker2, Alan Jackson1
1University of Manchester, Manchester, UK; 2Salford Royal Hospitals NHS Trust, Manchester, UK

Dynamic Contrast Enhanced (DCE) MRI was applied to areas of actively inflamed small intestine in sufferers of Crohn's disease. Pharmacokinetic analysis of the passage of contrast agent through the tissue microvasculature allowed measurement of blood plasma volume, extravascular extracellular space (EES) and transfer constant between blood plasma and EES. Comparison of these parameters from inflamed and normal bowel wall indicated measurable differences. The possibility of using such parameters as surrogate markers for disease activity is suggested.
15:10 438. Oral Contrast Agents for Small Bowel MRI: Comparison of Different Additives to Optimize Bowel Distension

Waleed Ajaj¹, Susanne C. Goehde¹, Roaya Jeyran¹, Hubert Schneemann¹, Stefan G. Ruhm¹, Joerg F. Debatin¹, Thomas Lauenstein¹
¹University Hospital Essen, Essen, Germany

The purpose of this study was to compare different osmotic carbohydrate solutions (2.5% mannitol, 2.0% / 1.5% sorbitol) for small bowel MR imaging regarding image quality and patient acceptance. 12 healthy volunteers underwent each four MR examination after ingesting 1500ml of the different contrast solutions. While best distension values were observed after both the administration of 2.5% mannitol and 2.0% sorbitol, the use of sorbitol led to less side-effects and should therefore be recommended for small bowel MR imaging.

15:20 439. ¹H NMR Spectroscopy for Diagnosis of Malabsorption Syndrome

Lakshmi Bala¹, Pratima Tripathi¹, Gowda A. Nagana Gowda², Uday Chand Ghosal², Asha Misra¹, Mahendra Bhandari¹, Chunni Lal Khetrapal³
¹Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

The use of proton NMR spectroscopy for D-xylene test in the diagnosis of malabsorption syndrome (MAS) is proposed. Urinary excretion (in 5h) of xylose after its oral ingestion (5g) was estimated and the values compared with those from conventional colorimetric method, for 35 adults with suspected MAS. The diagnosis was confirmed by fecal fat, Sudan stain and/or endoscopic duodenal biopsy. Colorimetry and NMR diagnosed 11/12 and 10/12 (p = non-significant) patients with MAS and 14/23 and 20/23 (p < 0.05) without MAS, respectively. NMR is rapid with better precision and specificity (7% and 86.9%) compared to colorimetry (20% and 60.7%).

Diffusion: Sequences and Schemes

Main Hall 16:00 - 18:00 Chairs: Roger J. Ordidge and David G. Norris

16:00 440. Focused High Resolution SENSE-DTI at 3 Tesla using a Micro Coil Array

Thomas Jaermann¹, Nicolas De Zanche¹, Klaas Paul Pruessmann¹, Anton Valavanis², Spyros Kollias², Peter Boesiger³
¹ETH and University Zurich, Zurich, Switzerland; ²University Hospital Zurich, Zurich, Switzerland

For DTI based on single-excitation spin-echo EPI the limitations in spatial resolution prohibit the detailed study of white matter organization. In this work we demonstrate that this issue can be addressed by parallel acquisition using a micro coil array consisting of three to five coils, each with a loop dimension of 35 x 70 mm. It is shown that such a configuration applied at 3 Tesla enables high quality sensitivity encoded (SENSE)-DTI and fiber tracking in regions which have been excluded so far due to inadequate image resolution and low anisotropy values, such as cortical gray matter.

16:12 441. Self-Navigated Diffusion Tensor Imaging with Interleaved Variable Density Spiral Acquisition

Chunlei Liu¹, Dong-Hyun Kim¹, Roland Bammer¹, Michael E. Moseley¹
¹Stanford University, Stanford, California, USA

Subject motion is a major source of image distortion and artifacts in diffusion-weighted MRI. Phase error induced by bulk motion has so far limited the use of multi-shot echo planar imaging approach. To compensate for eddy current, reduce motion artifacts, and improve phase navigation capabilities, we have implemented a twice-refocused spin echo sequence using a variable density spiral design. The VD spiral was designed such that the center of the k-space is excessively oversampled and served as an effective self-navigator. We show high resolution (256x256) in vivo diffusion tensor images with high SNR, great contrast, and significantly reduced geometric distortions.

16:24 442. Multi-Shot Diffusion-Weighted EPI with Readout Mosaic Segmentation and 2D Navigator Correction

David Porter¹, Edgar Mueller³
¹Siemens Medical Solutions, Erlangen, Germany

Multi-shot EPI sequences using mosaic segmentation acquire a contiguous set of k-space points at each spin excitation. This type of sampling lends itself well to non-linear 2D image-domain phase-correction, which is effective at removing motion artifacts in multi-shot diffusion-weighted imaging. An EPI sequence with 2D navigation and mosaic segmentation was used to acquire diffusion-weighted images of the brain in healthy volunteers. Mosaic segmentation was applied in the readout direction to allow a considerable reduction in the EPI echo-spacing compared to the single-shot case. The resulting navigator-corrected images showed no obvious motion artefacts and a low level of susceptibility artefact.
16:36 443. Diffusion Gradient Orientation Schemes for DTI Acquisitions with Unquiet Subjects
Jessica Dubois1, Cyril Poupon1, Yann Cointepas1, Franck Lethimonnier1, Denis Le Bihan1
1CEA, Orsay, France

In DTI, acquisitions must be performed for at least six diffusion gradients orientations. Tensor estimation accuracy increases with the spatial distribution and the number of orientations. But the time a subject keeps quiet in the magnet is not always predictable. Our goal was to implement orientation schemes which permit not to lose the whole data set in case of motion and so yield the best spatial information whatever the acquisition time. A model of electrostatic-like interactions between the orientations was considered, with different interaction coefficients according to the orientation sequence during acquisition. Three schemes were generated and tested in vivo.

16:48 444. Optimized Diffusion Tensor Encoding Schemes with Anisotropic Diffusion Weighting
Jee Eun Lee1, Andrew L. Alexander1
1University of Wisconsin, Madison, Wisconsin, USA

Optimum diffusion weighting factors for individual encoding directions were found to reduce the variances of FA measurements in regions where there was an a priori estimate of the apparent water diffusion tensor. In this study, the diffusion tensor encoding weights were optimized to minimize the variance of FA in the corpus callosum. Powell minimization was used to estimate the optimum diffusion weighting factors in 12 directions, leading to a roughly 50% reduction in the variance of FA for the corpus callosum. Experimental data verified the theoretical prediction.

17:00 445. 3D Diffusion Tensor Imaging with 2D Navigated and Online Motion Corrected RARE
Michael von Mengershausen1, David Gordon Norris2, Wolfgang Driesel3
1Max-Planck-Institute of Cognitive Neuroscience, Leipzig, Germany; 2F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, Netherlands

Conventional diffusion tensor imaging (DTI) methods suffer from limited spatial resolution. In this work a segmented 3D-DTI sequence is presented which improves this. It is realised by a diffusion weighted (DW), 2D navigated and online motion corrected TURBO spin-echo sequence (RARE) which is able to correct for phase errors due to bulk motion during the diffusion weighted preparation. As a result 3D DTI-maps are presented demonstrating that this method is a promising approach to high resolution DTI.

17:12 446. Data Collection and Post-Processing Strategies in Radial-FSE for Diffusion Tensor Analysis
Rexford D. Newbould1, Joelle E. Sarlls1, Theodore P. Trouard1
1University of Arizona, Tucson, Arizona, USA

By exploiting the repeated sampling of the low spatial frequencies in radial MRI, it is possible to partition one radial dataset into multiple datasets. In this work, this aspect has been used to reconstruct multiple high-resolution diffusion weighted images for DTI analysis from a single isotropic diffusion-weighted radial fast spin-echo dataset. By selecting the appropriate angular sampling, effective TE and diffusion weighting direction on each radial line, artifacts from motion, T2 decay, diffusion anisotropy and image misregistration are minimized. This method also allows great flexibility in sampling densities, allowing tradeoff between SNR and scan time.

17:24 447. Sub-Minute High Angular SENSE DTI at 3.0 Tesla for Fiber Tracking
Frank Hoogenraad1, Paul Folkers2, Ronald Holthuizen2
1Philips Medical Systems, Best, Netherlands

A high-angular DTI acquisition (15 diffusion directions) is performed using state-of-the-art hard- and software to acquire DTI images in less than a minute. These measurements are then used to create FA maps and perform fibertracking. It is shown that fibertracking can be performed with this sub-minute acquisition, which will allow high-angular DTI and fiber tracking to become a fast clinical procedure. The high SNR is a result of both the high field system (3.0 T) but also results from the short-TE that is only possible utilizing this ultra-strong gradient system (80 mT/m).

17:36 448. Full-Brain Q-Ball Imaging in a Clinically Acceptable Time: Application to White Matter Fibre Tractography
Jennifer Shane Williamson Campbell1, Kaleem Siddiqi2, G. Bruce Pike1
1Montreal Neurological Institute, Montreal, Quebec, Canada; 2McGill University, Montreal, Quebec, Canada

Q-Ball imaging is a method for calculating an orientation distribution function that strongly reflects the underlying white matter fibre structure, even in cases of partial volume averaging of white matter fibre directions. We demonstrate that the acquisition of the diffusion weighted images for QBI can be done in a clinically feasible amount of time, and demonstrate the use of the orientation distribution function in full-brain tractography. We also introduce a scalar anisotropy index for use with the reconstructed diffusion orientation distribution function.
Isotropic radial-FSE, a simple and effective method for obtaining high-resolution isotropic diffusion-weighted images from an individual radial data set, is demonstrated. In multi-shot radial MRI, the direction of diffusion weighting can be altered between TR periods yielding groups of radial lines possessing variable diffusion weighting. Because individual radial lines sample the center of Fourier space and contribute equally in reconstruction, appropriate diffusion directions can be chosen to yield images with effectively isotropic diffusion weighting in a single scan. In addition, isotropic radial-FSE can use full gradient strength on all three axes simultaneously enabling maximum b-values in minimum echo times.

MR PHYSICS AND TECHNIQUES FOR CLINICIANS

Room A 16:00 – 18:00  Chairs: Frank R. Korosec and Joseph C. McGowan

Educational Objectives
Upon completion of this course, participants should be able to:

• Define and describe the fundamental principles of MR imaging, including the definition of spin magnetization, the Larmor relationship, relaxation phenomena, and the process of using the spin magnetization to produce an image;
• Explain imaging pulse sequences based upon spin and gradient echoes, including fast spin echo and echo planar techniques;
• Design MR imaging protocols for diagnostic applications considering image contrast, spatial resolution, acquisition time, signal-to-noise ratio, and artifacts;
• Describe the principles and capabilities of various advanced MR techniques, including diffusion, cardiac and functional MRI and spectroscopy.

16:00  Imaging Features
Frank R. Korosec

16:40  Ultrafast Imaging
Marcus Alley

17:20  Diffusion Imaging
Konstantinos Arfanakis

18:00  Adjournment

Vascular MR Imaging: Illuminating the Wall

Annex 1 16:00 - 18:00  Chairs: René Botnar and Chun Yuan

Arterial-wall imaging by a multi-slice double-inversion fast-spin-echo pulse sequence suppresses blood signals optimally for only one of the slices. We demonstrate a new method for producing a relatively large number of black-blood slices. The slice order is reversed for echo trains acquired from the top half of k space relative to the bottom half. This imposes a phase modulation across k space that pushes the signal from moving blood into the imaginary component after Fourier transformation. An Expectation-Maximization algorithm then selects the real component. Blood-signal suppression with this technique was x10 on average.
16:12 451. **Rapid Dark Blood Imaging with High SNR from Random Velocity-Encoding Variation Method in Radial SSFP Acquisition**

Hung-Yu Lin¹, Chris Flask¹, Brian Dale¹, Claudia Hillenbrand¹, Jonathan Lewin¹, Jeffrey Duerk¹
¹Case Western Reserve University, Cleveland, Ohio, USA

The purpose of this study was to develop a radial steady-state free precession (SSFP) sequence with random amplitude velocity-encoding gradients applied prior to data acquisition. The effect of the random velocity-encoding gradients is to selectively dephase flowing spins at the center of K-space and lead to non-refocused velocity encoding over each repetition time so that flow signal is suppressed while preserving the high SSFP signal for stationary tissue. This acquisition technique can achieve high SNR and CNR in dark blood imaging with an extremely short acquisition time.

16:24 452. **MR Coronary Vessel Wall Imaging using Radial k-Space Sampling and Steady-State Free-Precession**

Marcus Katoh¹, Elmar Spenstrup¹, Arno Buecker¹, Matthias Stuber², Rolf W. Guenther¹, Rene M. Botnar³
¹RWTH Aachen University Hospital, Aachen, Germany; ²Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; ³Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Massachusetts, USA

We investigated the impact of radial k-space sampling and steady-state free-precession (SSFP) technique on image quality in 3D MRI of the coronary vessel wall. In eleven volunteers the right coronary artery vessel wall was studied using three different navigator-gated free-breathing black-blood sequences (Cartesian and radial gradient-echo (GRE) sequences, and radial SSFP). SNR and vessel sharpness as well as the subjective motion artifact level were analyzed. Motion artifacts were significantly reduced using radial k-space sampling. Superior SNR was found for SSFP-imaging. No difference was seen for vessel border definition among the three sequences.

16:36 453. **Dark-Blood True-FISP Imaging Using Dual Steady States**

Brian M. Dale¹, Chris A. Flask¹, Hung-Yu Lin¹, Jonathan S. Lewin¹, Jeffrey L. Duerk¹
¹Case Western Reserve University, Cleveland, Ohio, USA

Dark-blood imaging is important for a variety of clinical applications, especially vessel-wall imaging where nearby bright blood can obscure the signal from atherosclerotic plaques. The most common dark-blood technique is double-inversion magnetization preparation; however, this technique requires a prohibitive amount of time for applications such as screening for atherosclerotic plaques. True-FISP acquisitions are rapid, but have bright-blood due to the inflow effect. This abstract describes a novel dark-blood true-FISP imaging technique based on establishing separate steady states in and out of the plane and separating them in k-space. Using this technique, signal suppression of greater than 90% is typically achieved.

16:48 454. **Dynamic Contrast-Enhanced MRI Markers of Inflammation in Carotid Atherosclerosis**

William Sean Kerwin¹, Kevin O'Brien¹, Marina Ferguson¹, Thomas Hatsuksami¹, Chun Yuan¹
¹University of Washington, Seattle, Washington, USA

Two indices of carotid plaque enhancement are proposed based on kinetic modeling of dynamic contrast-enhanced (DCE) MRI and shown to closely correlate with histological measures of inflammation. Inflammation plays a role in the initiation of atherosclerosis and the plaque disruption that leads to clinical events. Thus DCE-MRI may be a valuable tool to non-invasively detect inflamed plaques or to monitor response to anti-inflammatory treatment. This investigation specifically shows that two plaque level parameters measured in vivo – the partial plasma volume and the transfer constant – correlate with ex vivo amounts of macrophages, the predominant cells of plaque inflammation.

17:00 455. **Lipid-Rich Atherosclerotic Plaque Detection In Vivo Using Gadofluorine and MRI**

Marc Siroi¹, Vitali V. Iskovich², Venkatesh Mani¹, Juan Gilberto S. Aguinaldo¹, Hanns-Joachim Weinmann¹, Bernd Misselwitz², John T. Fallon¹, Valentin Fuster¹, Jean-François Toussaint¹, Zahi A. Fayad²
¹Mount Sinai School of Medicine, New York, New York, USA; ²Schering, Berlin, Germany; ³Hôpital Européen Georges Pompidou, Paris, France

Recent studies have shown that Gadofluorine (Schering, AG) improved plaque detection in atherosclerotic rabbits at 48 hours post injection, compared to conventional contrast-enhanced MRI. In this study, we assessed the ability of Gadofluorine to characterize lipid-rich plaques and improved MR plaque imaging in vivo.

17:12 456. **VAS: A Comprehensive System to Classify High Risk Atherosclerotic Plaques**

Ying Luo¹, Chun Yuan¹
¹University of Washington, Seattle, Washington, USA

Vascular Analysis System (VAS), a comprehensive pattern recognition system, was developed to study if image features from in vivo high resolution MR images of atherosclerotic carotid plaque can be used to classify the patient’s neurological symptomatic state. Previous studies have shown that a multi-contrast weighted MRI is required and able to characterize plaque morphology and tissue composition. Ultimately, such information may enable one to differentiate those vulnerable plaques from stable plaques. Promising results were obtained by VAS for the symptomatic/asymptomatic patient classification. We conclude that this system may be effective in characterizing plaque features that are linked to patient symptoms.
**Quantification of Mural Thrombi with a Fibrin-Specific MRI Contrast Agent using an Image Segmentation Algorithm**
Edward C. Parsons, Jr.¹, Jufeng Wang¹, Andrea J. Wiethoff¹, John A. Barrett¹, Phil B. Graham¹, Robert M. Weisskoff¹
¹EPIX Medical, Inc., Cambridge, Massachusetts, USA

Automated iterative thresholding and statistical ROI comparison was used to segment thrombi from 3D MR images of carotid arteries in rabbits. Contrast was provided by the fibrin-specific gadolinium-based contrast agent EP-2104R (EPIX Medical, Cambridge, MA). The agent provided sufficient contrast to quickly quantify thrombus volumes with minimal input.

**Quantifying Plaque Burden of Human Atherosclerotic Plaque Using Cluster Analysis and Active Contours: Toward Improved Analysis**
Daniel D. Samber¹, Vitalii V. Itskovitch¹, Venkatesh Mani¹, Juan Gilberto S. Aguinaldo¹, Marc Sirol¹, Cheuk Y. Tang¹, Zahi A. Fayad¹
¹Mount Sinai School of Medicine, New York, New York, USA

In the present study, cluster analysis and active contours are applied to in-vivo MR images in order to quantify plaque burden. Comparison of plaque burden as determined by a semi-automated algorithm with plaque burden as assessed by expert readers validated the usefulness of the technique. Our analysis approach may further the clinical application of atherosclerotic vessel wall imaging.

**Precision Measurement of Carotid Artery Stenosis Using the Isosurface Deformable Model and Skeletonization**
Peter J. Yim¹, Monica Mishra¹, J Kevin Demarco¹
¹UMDNJ-Robert Wood Johnson Medical School, New Brunswick, New Jersey, USA

A novel methodology is presented for measurement of the degree of stenosis of the carotid artery from contrast-enhanced magnetic resonance angiography. The methodology is based on the Isosurface Deformable Model and Ordered Region Growing skeletonization. Together, these algorithms are used to detect the centerline of the vessel and to quantify the degree of stenosis. The methodology compares favorably with manual measurements in 10 carotid arteries by significantly reducing inter-observer variability (p = 0.0059).

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**MR Imaging and Spectroscopy in Multiple Sclerosis**
Sakura

**Increased Perfusion in Hypointense Multiple Sclerosis Lesions: A Marker of Lesion Reactivity?**
Yulin Ge¹, Meng Law¹, Glyn Johnson¹, Lois J. Mannon¹, Joseph Herbert¹, Robert I. Grossman¹
¹New York University Medical Center, New York, New York, USA; ²Hospital for Joint Diseases, New York, New York, USA

Vascular inflammation in brain is the critical event in the pathogenesis of multiple sclerosis (MS). MS plaques are typically developed along venous structures and tend to disappear and reappear on MRI during the disease progression. In this study, we have investigated the cerebral hemodynamic changes in different MS lesion types, i.e. enhancing and hypointense lesions, using absolute measurements of quantitative dynamic susceptibility contrast MRI. Our results showed increased perfusion in enhancing lesions and in some (27%) nonenhancing hypointense lesions compared to normal appearing white matter, indicating that the increased perfusion in hypointense lesions may associate with the lesion reactivity.

**Myelin Water Imaging in Multiple Sclerosis: Quantitative Correlations with Histopathology**
Cornelia Laule¹, Esther Leung¹, David K.B. Li¹, Anthony L. Traboulsee¹, Donald W. Paty¹, Alex L. MacKay¹, G.R. Wayne Moore¹
¹University of British Columbia, Vancouver, British Columbia, Canada

In-vivo measurement of myelin with multi-echo MRI promises to be invaluable in understanding neurological diseases like multiple sclerosis (MS). However, pathological studies must first validate MR derived measures claiming to be related to myelin content. Eighteen formalin-fixed MS brain samples underwent a 32-echo T2 relaxation experiment which measured myelin water fraction (MWF). Samples were then stained for myelin and axons. MWF correlated strongly with pathological myelin optical density [mean(range):R²=0.67(0.48-0.92),p<0.0001], as well as with axonal optical density [mean(range):R²=0.59(0.32-0.85),p<0.0001]. This study supports using myelin water imaging to investigate myelin pathology and the role of demyelination and remyelination in diseases like MS.
An optimized inversion-recovery, multiple spin-echo pulse sequence was developed to quantify the myelin water in human cervical spinal cord. Five normal volunteers underwent the reproducibility study. The preliminary results show promising consistency. Six normal volunteers and four MS patients with visible cord lesions then underwent a series of comprehensive MR studies including magnetization transfer ratio (MTR), diffusion tensor imaging (DTI) and myelin water quantitation. The correlation of the myelin water with MTR and DTI was analyzed.

Cross-relaxation imaging (CRI) is a new quantitative MRI method, which allows mapping of fundamental parameters determining the magnetization transfer in tissues: cross-relaxation rate constant and bound pool fraction. Using the presented CRI technique, three-dimensional entire-brain maps of these parameters can be obtained in clinically acceptable time. The purpose of this study was to evaluate anatomic correlations of cross-relaxation parametric images in the normal brain. The most interesting findings were the conspicuous visualization of major white matter fiber tracts as regions of consistently elevated bound pool fraction and the specific appearance of the corticospinal tract on maps of the rate constant.

Multiple sclerosis (MS) lesions show differing degrees of demyelination. Magnetization transfer ratio (MTR) is a marker of myelin content, however, there is no method to quantify remyelination potential. We hypothesized that lesion remyelination or demyelination, measured by MTR change over time, would be related to baseline lesion MTR signal inhomogeneity. Studying patients at baseline and after 2 months, we found that lesion voxels which significantly decreased in MTR on follow-up, had higher baseline MTR signal inhomogeneity compared to lesion voxels which increased in MTR (p<0.001). This suggests that local MTR signal inhomogeneity provides a method for quantifying lesion remyelination potential.

Tests of cognitive functions were performed on 37 patients with multiple sclerosis (MS) at baseline and 6 months later as part of a clinical trial to enhance cognition with an acetylcholinesterase inhibitor (donepezil). Partial correlation analysis, controlling for age, education, and drug treatment effects, revealed significant positive correlations between baseline 1H MRS measures of posterior periventricular NAA/Cr, NAA/Cho ratios and baseline, as well as 6-month cognitive performances, suggesting that 1H MRS examinations may serve as valuable predictors of cognition after 6 months, and may potentially play important roles in clinical management of MS patients.

Controversy exists about metabolite concentrations in MS NAWM: unchanged as well as decreased NAA levels have been observed. Quantitative single voxel MRS was performed bilaterally in carefully selected NAWM of 68 MS patients and WM of 24 controls. Increases were found in MS NAWM for Ins and tCr, suggesting increased numbers of glial cells. tNAA was unchanged compared to control WM, as well as the purely neuro-axonal component NAA, while NAAG showed a small but significant increase. In conclusion, our results suggest glial increase but there is no evidence for neuro-axonal damage in MS NAWM.

The TE-averaged PRESS spectroscopy acquisition at 3T enables the unobstructed single resonance detection of Glutamate along with other metabolites. Levels of glutamate, glutamine, myo-inositol and NAA in Multiple Sclerosis lesions and normal appearing white matter are compared with normal control white matter. The results support the link between acute MS lesions and altered glutamate metabolism. We also found evidence for excess glial activity in NAWM and MS lesions.
Changes in the MR parameters of inflammed neural tissue were measured in vitro. Tumor necrosis factor - alpha (TNF-α) was injected into rat sciatic nerve to induce inflammation with negligible axonal loss and demyelination. The average T₁ and T₂ relaxation times increased with inflammation, whereas the magnetization transfer ratio (MTR) and the quantitative MT parameter M₀B, describing the semisolid pool of protons, decreased. The MR parameters correlated very well with the extracellular volume fraction of neural tissue evaluated by quantitative histopathology.

The MR properties of demyelinated rat sciatic nerves were measured in vitro at 1.5 T. To induce the process of demyelination without inflammation and axonal loss, Telurium diet in weanling rats was used. The MR results were compared to quantitative histopathology. Most of the MR parameters changed with demyelination and correlated very well with histomorphometric assessment of myelin.

**Thermotherapy Assessment**

**Annex 2  16:00 - 18:00          Chairs: Jacco A. de Zwaart and John D. Hazle**

16:00 470.  **Young Investigator Awards Finalist: MRI Guided Focused Ultrasound: Automatic Spatial-and-Temporal Control of Temperature Evolution within a Large Treatment Volume**

*Rares Salomir¹, Charles Mougenot¹, Jean Palussière², Nicolas Grenier³, Christ Moonen¹*

¹Université Bordeaux 2, Bordeaux, France; ²Bergonie Institute, Bordeaux, France; ³CHU - Radiologie, Bordeaux, France

An automatic spatial-and-temporal temperature controller was designed for MRI-guided focused ultrasound thermotherapy, within an extended treatment volume as compared to the focal spot size. An elliptical ROI (up to 20 mm diameter) is repeatedly covered with inside-out spiral trajectories of the focal point. The controller uses the 3D real-time temperature maps to adapt the time course of the focal point displacement based on the PID-principle, in order to reach a uniform thermal build-up. The system demonstrated stability and accuracy in-vivo (rabbit thigh model).

16:20 471.  **MR-Guided Laser Pulmonary-Vein Ablation in Canine Models**

*Ehud J. Schmidt¹, Vivek Y. Reddy², Godtfred Holmvang³, Gerald Melsky¹*

¹GE Medical Systems ASL, Boston, Massachusetts, USA; ²Massachusetts General Hospital, Boston, Massachusetts, USA; ³CardioFocus Inc., Norton, Massachusetts, USA

A CardioFocus Inc. prototype MRI-compatible laser-balloon ablation catheter is utilized for ablation of the pulmonary veins, a procedure performed to cure atrial fibrillation. MRI guidance provides accurate positioning, balloon deployment and monitoring of heat delivery.

16:32 472.  **MRI-Monitoring of Heating Produced by Ultrasound Absorption in the Skull: In Vivo Study in Pigs**

*Nathan McDannold¹, Randy L. King¹, Kullervo Hynynen¹*

¹Harvard Medical School & Brigham and Women's Hospital, Boston, Massachusetts, USA

We show that MRI temperature mapping can monitor the heating induced in the scalp and brain due to ultrasound absorption in the skull with in vivo experiments in pigs. Measured temperature values were 2.8 ± 0.6 C and 4.4 ± 1.4 C on the brain surface and scalp respectively for an acoustic intensity on the skull surface of 1.3 W/cm². These measurements, along with those of previous work, indicate that skull heating will not limit the ability to thermally ablate brain tissue with ultrasound at a frequency of 0.69MHz, but that cooling of the head may be necessary in some cases.

16:44 473.  **MRI Monitoring of Focused Enhanced Ultrasound Heating in the Presence of an Ultrasound Contrast Agent in the Rabbit Brain**

*Nathan McDannold¹, Natalia Vykhodtseva¹, Ferenc Jolesz², Kullervo Hynynen¹*

¹Harvard Medical School & Brigham and Women's Hospital, Boston, Massachusetts, USA

We used MRI to monitor focused ultrasound exposures in the presence of an ultrasound contrast agent in the rabbit brain. These agents are promising since they make targeting structures that are near bone more practical since the power requirements are lower. The temperature distributions could be mapped with MR thermometry, and they matched the shape of the tissue damage. In some cases, heating occurred out of the focal zone in the ultrasound beam path or near blood vessels. The threshold for damage was reduced by a factor of ten.
16:56 474. Simultaneous Monitoring of Temperature and R1: Methods and Preliminary Results of Application to Heating of Thermosensitive Paramagnetic Liposomes
Clemens Bos1, Matthieu Lepetit-Coiffé2, Bruno Quesson1, Christ T.W. Moonen1
1Université ‘Victor Segalen’ Bordeaux-2, Bordeaux, France; 2Image Guided Therapy SA, Pessac, France

A method is presented to obtain temperature and R1 measurements simultaneously and in near-real-time from fast Look-Locker EPI data. R1 values are obtained from the signal magnitude. Phase information from all samples on the recovery curve is integrated to provide temperature values using the proton resonance frequency method. Utility of this technique is illustrated in an in vitro experiment with thermosensitive liposomes, which are considered as potential vehicles for local drug delivery. The method allowed following the relaxivity evolution during RF-heating of liposomes containing a paramagnetic contrast agent, which is related to an increase of liposome permeability with temperature.

17:08 475. Contrast Kinetics as a Histopathological Surrogate for Improved Assessment in Thermal Therapy
Hai-Ling Margaret Cheng1, Carrie M. Purcell2, Juan M. Bilbao2, Donald B. Plewes2
1Hospital for Sick Children, Toronto, Ontario, Canada; 2Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario, Canada

Conventional MR assessment of thermal lesions provides limited differentiation of tissue damage, making difficult the identification of margins. This study explores the usefulness of Gd-DTPA kinetics for improved tissue characterization and early prognosis. Thermal lesions induced by focused ultrasound were studied in rabbit muscle up to 1 week post-ablation, and MR-histology correlation was performed for all lesions. Results showed that kinetics maps offer improved assessment over conventional MRI. Kinetics maps can detect a broad spectrum of tissue changes not otherwise visible, and they predict latent changes and the full extent of necrosis earlier than standard MR techniques.

17:20 476. Saline-Enhanced Radiofrequency Thermal Ablation: Is it Associated With Complete Tissue Necrosis within the Induced Thermal Lesion?
Shervin Rafie1, Sherif Gamal Nour1, Michael S. Breen1, John Jesberger1, Jeffrey L. Duerk1, Jonathan S. Lewin1, Mark Rodgers1
1Case Western Reserve University, Cleveland, Ohio, USA

Previous work demonstrated the ability of saline enhanced RF ablation to generate larger thermal lesions. However, lesions induced by this technique demonstrate ill-defined hyperintense zones within the area of presumed coagulation, raising the question whether complete tissue necrosis has been achieved. We reinvestigated the MRI appearance of saline-enhanced thermal lesions and performed a correlation to histological cell damage. Saline-enhanced RF ablation appears to be associated with complete cell death within a sharply demarcated area of coagulation necrosis. This work supports the hypothesis that saline-enhance thermal ablation can facilitate increased thermal lesions while effectively eliminating viable tissues within the targeted zone.

17:32 477. Correlation of Real-Time MRTI and Post-Treatment MRI with Histologic Depiction of Prostatic Ablation using High-Intensity Ultrasound
Graham Sommer1, Kim Butts1, Donna Bouley1, Bruce Daniel1, Tony Ross2, William Nau2, Chris Diederich2
1Stanford University, Stanford, California, USA; 2UCSF Radiation Oncology, San Francisco, California, USA

In an in vivo study of prostatic ablation using high-intensity ultrasound, 7 canine prostates were ablated using MRTI guidance. Post-treatment histologic results were compared to MRTI and post-ablation MRI. Using MRTI, zones of ablation corresponded well to cumulative temperature maps indicating Tmax of ~52 °C and t43> 240 min. T2-weighted imaging did not reveal ablated regions of prostate, but ablated regions were identifiable as zones of reduced ADC in DW images, and post-contrast T1-weighted images gave the best depiction of the ablated regions as zones of reduced perfusion. Histology showed central “heat-fixed” zones of ablation surrounded by coagulative necrosis.

17:44 478. Appearance of Rimlike Regenerative Tissue Enhancement after Radiofrequency Ablation: Postprocedural Assessment with Different Radiological Techniques
Florian M. Vogt1, Gerald Antoch1, Patrick Veit2, Sandra Mässing2, Jörg F. Debatin1, Stefan G. Rühm3, Hilmar Kühl1
1University Hospital, Essen, Germany

Purpose was to assess different imaging modalities for the assessment of rim like enhancement of liver lesions after radiofrequency ablation which may aggravate the differentiation of residual viable tumor. In 14 pigs, two necrotic lesions with a diameter of 3 cm were induced by radiofrequency thermoablation. Follow-up was performed by contrast enhanced MRI, CT and US immediately after treatment and between 3 days and 6 months thereafter. Presence and degree of contrast enhancement around the liver lesions was assessed. All modalities revealed rim like tissue enhancement in the arterial contrast agent phase up to 6 months following the thermoablation.
Computational Electromagnetics

Room D  16:00 - 18:00  Chairs: Stuart Crozier and Tamer S. Ibrahim

16:00  479. A FDTD Model for the Calculation of Gradient-induced Eddy Currents in MRI Magnets

Feng Liu1, Stuart Crozier1
1School of Information Technology and Electrical Engineering, Brisbane, Queensland, Australia

This paper presents a 3-D FDTD scheme in cylindrical coordinates for eddy current calculations in magnet conductors. The singularity apparent in the governing equations is removed by series expansions and the conductor-air boundary condition is incorporated using a variant of the surface impedance concept. The numerical difficulty due to the ‘asymmetry’ of Maxwell equations is circumvented by taking advantage of the known penetration behavior of the eddy-current fields. The proposed numerical scheme is implemented, verified against a problem with a known analytical solution and an MRI-based numerical example is provided to illustrate the utility of the algorithm.

16:12  480. Resistance Effect on Eddy Currents in Conducting Cryogenic Warm Bore Cylinders

T. K. Kidane1, T. P. Eagan1, Y.-C. N. Cheng1, V. Taracila1, T. N. Baig1, W. A. Edelstein1, R. W. Brown1
1Case Western Reserve University, Cleveland, Ohio, USA; 2MRScience, Schenectady, New York, USA

Two ways of calculating eddy currents are considered for a shielded z-gradient design on the conducting cryogenic warm bore, the quasi-static field method and the network method. These two methods give identical results if the resistance is neglected and the time dependence of the eddy current is identical to that of the driving current. On the other hand, when we take the resistance into account the network method gives a reduced and an exponentially decaying residual eddy current. This method can also give an insight into the skin depth effect by further slicing the cylindrical warm bore into concentric layers.

16:24  481. Simulated Noise in MRI Systems Caused by Magnet "Warm-Bore" Eddy Currents

Victor Taracila1, Tesfaye Kidane1, Timothy Eagan1, Tanvir Baig1, Yu-Chung Norman Cheng1, William Edelstein1, Robert Brown1
1Case Western Reserve University, Cleveland, Ohio, USA; 2MRScience LLC, Schenectady, New York, USA

In MRI medical diagnostic systems, there is considerable acoustic noise leading to patient discomfort. The noise is generated by the interplay between Lorentz forces and the rapid current changes of pulsed gradient-field coils located in magnetic field strengths in the Tesla range. These forces generate stresses in MRI system components, exciting a spectrum of mechanical normal modes. We focus in this paper on an analytical calculation of the noise generated by eddy currents produced in the “warm bore” of the main magnet MR coil in response to the gradient coil field time dependence.

16:36  482. A Computational Study of Image Shading due to Matching Circuitry, in Head Resonators at 3.0 T

James S. Tropp1
1GE Medical Systems, Fremont, California, USA

The perturbed current distribution due to matching circuitry is calculated for a realistic model of a lossy bird cage head resonator at 3.0 T; and these currents are then used in an electromagnetic model to simulate the image of a lossy dielectric phantom. A small intensity perturbation ~ 3% at the periphery of the image is shown to result, and it is concluded that 4-point quadrature drive is not required for imaging the head at 3.0 T, but that conventional 2-point drive suffices.

16:48  483. Current Distribution in a Large Volume Coil at 11.1 Tesla

Barbara L. Beck1, Rick T. Goldberg1, Jeffrey R. Fitzsimmons1
1University of Florida, Gainesville, Florida, USA

Severe B1 inhomogeneities may be caused by wave behavior within the sample or non-ideal current distribution in the coil. Interaction between the coil and the sample may cause a disturbance to the ideal current distribution. If the disturbance is great enough, a homogeneous B1 field will not be generated. Equally, if ideal current distribution is maintained, but a severe B1 homogeneity is present, it can be concluded that the inhomogeneity is due to wave behavior in the phantom. This work employs Finite Difference Time Domain simulation to study the current distribution and field in a large coil at 470MHz.

17:00  484. Calculations of RF Power Absorbed by the Portions of a Human Body Inside and Outside a Body Coil's Imaging Volume at 64 and 128 MHz

Wanzhan Liu1, Christopher Michael Collins1, Qing X. Yang1, Michael Bruce Smith1
1Penn State College of Medicine, Hershey, Pennsylvania, USA

The RF power absorbed by the portions of the human body inside and outside of a body coil’s imaging volume was calculated at 64 and 128 MHz. The percentage of input power absorbed by the body outside the coil’s imaging volume at 128 MHz is twice as much as that at 64 MHz, but still less than 10% of the total absorbed power. This might be caused by more power radiated out of the RF coil, and eventually absorbed in the outside portion of the body at the higher frequency.
Towards the Optimum 7T Head RF Coil
Graeme McKinnon1, Eddy Boskamp1
1GE Medical Systems, Waukesha, Wisconsin, USA

Numerical simulations were used to find the optimal configuration for a 7T head coil. The high-pass birdcage, the hybrid birdcage, and the TEM resonator were compared. The coil dimensions were kept as similar as possible. Performance was evaluated on the basis of peak E field, SNR, and B1+ uniformity. Over the range investigated, the hybrid coil had the lowest peak E field, the birdcage coils the better SNR, and the TEM the best uniformity.

A Distributed Equivalent-Magnetic Current Based FDTD Method for the Evaluation of the Eddy Currents Induced by Pulsed Gradient Fields
Feng Liu1, Stuart Crozier1, Qing Wei1
1School of Information Technology and Electrical Engineering, Brisbane, Queensland, Australia

The FDTD method has been employed to calculate the gradients induced eddy current. Many technical problems have already been solved to some extent; however, it has to be improved further to effectively handle low-frequency gradient field modelling problems. To circumvent the mapping of the complicated coil geometry into Yee’s staggered meshes, a distributed equivalent magnetic current based method has been proposed. It has been demonstrated that how the total/scattered field concept can be used to formulate a novel algorithm, where the electromagnetic source can be obtained by quasistatic calculation of the empty coil’s vector potential or measurements therein.

Comparison of B1 Field Homogeneity for Shielded Birdcage, TEM and Microstrip Volume Coils at 300MHz
Chunsheng Wang1, Jing Yuan1, Bing Wu1, Gary X. Shen1
1The University of Hong Kong, Hong Kong, People's Republic of China

In this work the B1 fields of shielded birdcage, TEM and microstrip volume coils were simulated by the finite difference time domain (FDTD) method at 300MHz under the same geometry conditions. The simulation results indicate that the shielded birdcage coil has better B1 field homogeneity compared with the TEM and microstrip volume coils, but might have more radiation loss than the TEM and Microstrip volume coils.

Computational and Experimental Analysis of Electromagnetic Fields Induced by RF Coils for High Field Imaging
Tamer Selim Ibrahim1, Chad Mitchell2, Petra Scmalbrock2, Donald Chakeres2
1The University of Oklahoma, Norman, Oklahoma, USA; 2The Ohio State University, Columbus, Ohio, USA

In this work, we numerically and experimentally analyze the MR signal. This was accomplished through the use of a TEM resonator and computational electromagnetics. The results demonstrate the effectiveness of the computational electromagnetics, most especially when it is rigorously applied to study volume coils and shows tremendous insight into the operation of volume coils for high field imaging. Analysis of the electromagnetic fields polarizations is shown at low and high field MRI with respect to loaded and unloaded coils.

fMRI Data Analysis

Room B-1  16:00 - 18:00           Chairs: Xiaoping Hu and Robert Turner

An Index of Scanner/Site Differences in fMRI Sensitivity: Method and Implications
Lee Friedman1, FIRST BIRN2
1The MIND Institute, Albuquerque, New Mexico, USA; 2National Center for Research Resources, Bethesda, Maryland, USA

The FIRST BIRN project is attempting to merge fMRI data from 11 MRI scanners. Multi-site fMRI studies present difficult challenges, due to marked scanner and sequence differences. We are developing methods to produce similar activation patterns across sites, and have developed a simple index of scanner sensitivity based on the matching of activation patterns to an exemplar. We note that there are significant “scanner/site” differences in this index. We are working on explaining these differences in terms of scanner and image characteristics and adjusting for these differences. The final result should be more comparable activation patterns across multiple platforms.

ROC Methods in fMRI with Real Data Using Repeated Trials: Limitations and Improvements
Rajesh Ranjan Nandy1, Dietmar Cordes1
1University of Washington, Seattle, Washington, USA

A new receiver operating characteristic (ROC) method has been proposed previously using real fMRI data by Le and Hu, where the locations of truly active voxels are determined using a conservative statistical test. Limitations of the method are discussed using mathematical relationships between the true ROC curve and the proposed ROC curve. A modification of the method is suggested in this article which improves upon the previous method. Also discussed is a method based on p-values to reconstruct the true ROC curve from the ROC curve proposed by Le and Hu. Several examples are provided to illustrate the ideas introduced.
Combining Voxel Intensity and Cluster Extent with Permutation Test Framework

Satoru Hayasaka¹, Thomas E. Nichols¹
¹University of Michigan, Ann Arbor, Michigan, USA

In fMRI analysis, cluster size tests can be more sensitive than voxel intensity tests when signals have large extent. We consider joint intensity extent inference methods which are sensitive to clusters with either high intensity or large extent. We propose the use of different combining functions. Of our different combining methods, none is optimal, so we combine these joint methods and additionally propose a meta-combining inference which incorporates the strengths of different combining functions. We found that our proposed methods are sensitive to different types of signals, and our meta-combined test further improves the sensitivity.

A Mutual Information-Based Approach to Estimate the Number of Meaningful Independent Components from ICA Decomposition of fMRI Data

Radu Mutihac¹, Joe Gillen²
¹University of Bucharest, Bucharest, Romania; ²Kennedy Krieger Institute, Baltimore, Maryland, USA

The contribution seeks for identification of relevant independent components out of ICA decomposition of fMRI data. Mutual information, defined by means of Kullback-Leibler divergence, constitutes a statistically natural measure of independence between distributions of random variables. Generating synthetic components starting from selected real life fMRI data, it was proven that mutual information contains reliable information on the number of the underlying sources of meaningful brain activity in spatial ICA decomposition of fMRI data sets.

Hypothesis-Driven Independent Component Analysis (hICA): Incorporating Prior Knowledge about the Hemodynamic Response into ICA Analysis of fMRI Data

Vincent J. Schmithorst³
³Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA

A method is proposed for incorporating prior knowledge about the expected form of the hemodynamic response function (HRF) into Independent Component Analysis (ICA) of functional MRI (fMRI) data. The method avoids many of the difficulties with standard ICA procedures, such as the optimal amount of data reduction and the a posteriori designation of components as task-related or confound. Computer simulations showed the accuracy of the method to be comparable to standard General Linear Model (GLM) procedures, even with inaccurate modeling of the task regressor, and much superior to standard ICA or GLM with inaccurate modeling of the confound regressors.

Voxel Power for Repeated Measures ANOVA with Nonsphericity

Mark McAvoy¹, Tim Brown¹, Harold Burton¹, Brad Schlaggar¹, Steve Petersen¹
¹Washington University, St. Louis, Missouri, USA

Repeated measures analyses of variance are mixed effect designs with subjects as the random effect and the experimental conditions as fixed effects. Of practical interest is the power of such designs and the number of subjects needed to discern functional changes in the brain. If the analysis includes factors at more than two levels then correlations within and between the factor levels must be examined. These correlations express themselves in the covariance matrix and are quantified as a correction for nonsphericity. The power calculations include an adjustment for the nonsphericity of the underlying covariance matrix.

Head-Motion Suppression Using Real-Time Feedback of Motion Curves and Its Effects on Performance of Task in fMRI

Shaolin Yang¹, Thomas J. Ross¹, Yangqiong Zhang¹, Hanhua Feng¹, Elliot A. Stein², Yihong Yang¹
¹National Institutes of Health, Baltimore, Maryland, USA; ²Columbia University, New York, USA

A voluntary head-motion suppression method by letting subjects watch their own head motion parameteric curves in real time is proposed. A real-time fMRI analysis system is developed for this purpose. The method was tested and the possible influence of watching the head motion curves on the performance of neurological tasks in fMRI study was investigated using an auditory N-BACK task. A reduction in head motion was observed without significant influence on the performance accuracy and reaction time. However, interference on the brain activation was found in the working memory task, and further improvement is necessary.

Modelling fMRI Motion Artefacts using a Simulated Scanner

Ivana Drobnjak¹, Mark Jenkinson¹
¹University of Oxford, Oxford, UK

A simulated scanner was implemented, based on solving the Bloch equations for a general pulse sequence in order to quantitatively model motion artefacts in fMRI. This simulation was run using an EPI sequence, allowing the precise amounts of within-scan blurring and spin history artefacts to be found for a model of the brain undergoing typical motions. The results show that spin history induces a change of similar magnitude to within-scan motion effects.
17:36 497. **Motion or Activity: Their Role in Intra- and Inter-Subject Variation in fMRI**  
Torben E. Lund1, Minna Dorte Nørgaard2  
1Danish Research Centre for MR, Hvidovre, Denmark

Functional MRI possesses large intersession variability. This is problematic with regard to brain mapping, but not least to the application of fMRI for presurgical planning. The purpose of this study was to investigate whether the inclusion of regressors, describing movement-related effects, in the design matrix of a General Linear Model (GLM) reduces intra-subject and inter-subject variability in the observed fMRI activation. Ten subjects were examined using two different language tasks, and two of the subjects were examined 10 times. Inclusion of motion parameters in the analysis significantly reduced both the intra- and intersubject-variation.

17:48 498. **Group Phase Delay Affects the Measurement of Functional Synchrony**  
Yin Xu1, Guofan Xu1, Gaohong Wu1, Shi-Jiang Li1  
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

COSLOF index (the mean of the cross-correlation COefficients of Spontaneous LOw Frequency) was introduced to measure the functional synchrony in the hippocampus among cognitively healthy elderly subjects and Alzheimer’s patients. To investigate the mechanism of the lower COSLOF index in Alzheimer’s patients, we have tested three possible causes: a decrease in the fluctuation intensity of the spontaneous low frequency (SLF), a difference in frequency components, and phase delay between voxel time courses. Our results demonstrated that the difference in the COSLOF index is due to phase delay between voxel time courses instead of frequency or intensity of SLF.

**Liver MR: Focal, Diffuse, and Metabolic**

Room B-2  
16:00 - 18:00  
Chairs: Hero K. Hussain and Luigi Grazioli

16:00 499. **Accurate Differentiation of Focal Nodular Hyperplasia from Hepatic Adenoma and Liver Adenomatosis with Gadobenate Dimeglumine (Gd-BOPTA)**  
Luigi Grazioli1, Gianni Morana2, Miles Kirchin3, Gunther Schneider4  
1Spedali Civile, Brescia, Italy; 2Policlinico Borgo Roma, Verona, Italy; 3Bracco Imaging Spa, Milan, Italy; 4Universitätskliniken des Saarlandes, Homburg/Saar, Germany

The ability of gadobenate dimeglumine (Gd-BOPTA, MultiHance®) to differentiate FNH from hepatic adenoma (HA) and liver adenomatosis (LA) was evaluated in 109 patients with confirmed lesions. Images were acquired before (T2wTSE and T1wGRE sequences) and during the dynamic and delayed phases after (T1wGRE sequences) the bolus injection of 0.1 mmol/kg Gd-BOPTA. Accurate differentiation was not possible on pre-contrast images or on post-contrast dynamic phase images. On delayed phase images 124/128 (97%) FNH appeared hyper- or isointense while 107/107 (100%) HA/LA appeared hypointense. The sensitivity, specificity, PPV, NPV and overall accuracy for differentiation was 96.9%, 100%, 100%, 96.4% and 98.3%, respectively.

16:12 500. **The Mechanism of Ring Enhancement in Malignant Hepatic Tumors on SPIO-Enhanced T1-Weighted Images: An Investigation Into Peritumoral Kupffer Cells**  
Akihiro Tanimoto1, Hiroshi Shinmoto1, Shigeo Okuda1, Sachio Kuribayashi1, Go Wakabayashi1, Makio Mukai1  
1Keio University School of Medicine, Tokyo, Japan

To investigate the mechanism of ring enhancement on SPIO-enhanced T1W-GRE in malignant focal hepatic lesions, MR imaging findings and Kupffer cell (KC)-stain sections of 18 hepatocellular carcinoma were reviewed. Ring enhancement was noted in 13 of 18 HCC (72%). Peritumoral KC density significantly increased in ring enhancement (+) group as compared with ring (-) group. In ring (+) group, tumor size on T2W was smaller than those on T1W and T2*W, suggesting sustained T1 effect and decreased T2* effect in peritumoral region. Ring enhancement on SPIO-enhanced T1W may correlate with increased KC density and decreased SPIO clustering in KC.

16:24 501. **Distinction between Benign and Malignant Nodules in the Cirrhotic Liver with Multi-Phase Gadolinium-Enhanced MR Imaging**  
Hero K. Hussain1, Hanh V. Nghiem1, Saroja Adusumilli1, Ramsey Umar1, Robert J. Fontana1, Anna S. Lok1, Jorge A. Marrero1  
1University of Michigan Health System, Ann Arbor, Michigan, USA

Distinction between benign and malignant nodules in the cirrhotic liver is essential for planning transplantation. MR signal characteristics and enhancement patterns are not always specific, especially for small lesions. We found that lesion hypointensity on delayed post-gadolinium imaging to be a more specific than arterial enhancement for the diagnosis of hepatocellular carcinoma.
16:36 502. MR Elastography of in Vivo Human Liver

M. Alex Dresner1, Jeff Fidler1, Richard Ehman1
1Mayo Clinic, Rochester, Minnesota, USA

We report on a feasibility study of in vivo human liver MR Elastography (MRE). While contrast-enhanced MR is adequate for characterizing focal lesions within the liver, the mechanical properties of the organ are expected to change in the case of diffuse disease. Preliminary experiments have identified useful wave frequencies and estimates of liver shear stiffness. Methodological improvements now allow completion of 2-D MRE offset scans within 5-8 seconds, for breathold scans in human subjects. A novel mechanism of generating the displacements within the subject avoids the artifacts associated with electromechanical drivers without sacrificing displacement amplitude.


Jong-Hee Hwang1, Meredith Hawkins1, Daniel T. Stein1, Nir Barzilai1, Julia Tonelli1
1Albert Einstein College of Medicine, Bronx, New York, USA

Content of intramyocellular lipids (IMCL), intrahepatic triglycerides (IHTG) and visceral fat was quantified using 1H MRS and MRI in ten healthy subjects(9M,1F), together with glucose disposal rates(Rd) and leptin levels. There were remarkably strong correlations between IHTG and Rd (r=-0.78, P<0.001, r=0.73), and between IHTG and visceral fat (r=0.64, P=0.05), however, neither IHTG nor IMCL were correlated with subcutaneous fat. Leptin levels and Rd (r=-0.85, P=0.02) were negatively correlated.

17:00 504. MR Imaging for Quantitative Measurement and Display of Hepatic Fat Fraction: A Potential Replacement for Liver Biopsy

Hero K. Hussain1, Thomas L. Chenevert1, Vikas Gulani1, Scott Swanson1, Hari Conjeevaram1
1University of Michigan Health System, Ann Arbor, Michigan, USA

Non-alcoholic fatty liver disease is a common condition that may progress to cirrhosis. Liver biopsy is the only means of diagnosing this condition. Biopsy is an invasive procedure that carries potential risks. We propose a fast, non-invasive MR imaging method to accurately quantify and display the fat fraction in the liver. This method addresses the ambiguities associated with the dominant species, and the effects of NMR relaxation on the signal intensity.

17:12 505. A Novel Way to Follow Triglyceride Metabolism using 13C MRS

D. K. Deelchand1, J. E. M. Snaar1, B. Ravikumar2, R. Taylor2, P. G. Morris1
1University of Nottingham, Nottingham, UK; 2University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, UK

A technique has been devised to follow the incorporation and utilisation of dietary triglycerides in the liver and calf muscle in human subjects using in vivo carbon-13 magnetic resonance spectroscopy with a 98+% labelled lipid. 8 normal subjects were studied over a 24 hour period and diurnal variations demonstrated for the first time. This novel method will help to advance further research in many areas where lipid storage is vital, e.g. in diabetes mellitus or in patients with lipid defects.

17:24 506. Etiology and Functional Status of Liver Cirrhosis by 31P MR Spectroscopy

Monika Dezortova1, Pavel Taimr1, Julius Spicak1, Milan Hajek1
1Institute for Clinical and Experimental Medicine, Prague, Czech Republic

Quantitative 31P MR spectroscopy was used to assess the functional status and etiology of liver cirrhosis. 80 patients with liver cirrhosis of different etiology and severity and 11 healthy volunteers were examined at 1.5T using 2D-CSI 31P MR spectroscopy of the liver. Absolute concentrations of metabolites were calculated. Correlation between functional status described by Child-Pugh score and decreasing concentrations of PDE and ATP in liver was found. Based on differences in 31P MR spectra of patients to controls, we could also distinguish alcoholic, viral and cholestatic etiologies of liver cirrhosis. MR spectroscopy thus can be helpful in differential diagnosis.

17:36 507. Hepatic Glycogen Alteration in Response to Hypoglycemia: A 13C Spectroscopic Imaging Study

Jong-Hee Hwang1, Ilan Gabriely1, Preeti Kishore1, Min-Hui Cui1, Joseph Divito1, Hoby P. Hetherington1, Julie W. Pan1, Harry Shamoon1
1Albert Einstein College of Medicine, Bronx, New York, USA

To measure hepatic glycogen, one-dimensional 13C spectroscopic imaging (SI) was implemented using Gaussian weighted k-space encoding scheme at 4T. The 13C SI was utilized to monitor the time course of hepatic glycogen stores in response to modest hypoglycemia [~60mg/dl] by detection of C-1 glycogen. Separate hypoglycemic–hyperinsulinemic and euglycemic–hyperinsulinemic clamp studies were performed in humans while hepatic glycogen content was continuously measured using the method. By the end of the two-hour hypoglycemic clamps, hepatic glycogen decreased progressively by 17.9±3.1 % from the basal glycogen content. Conversely, the euglycemic studies were associated with a 13.9±11.0% increase in hepatic glycogen.
Tissue iron can be indirectly detected by the paramagnetic effects of iron on the shortening of water proton MR relaxation times. However, the dependence on experimental conditions such as pulse sequences and acquisition parameters complicates iron quantification with MRI. Currently there is no accepted MRI approach available for clinical application. In this study, we implemented a number of optimized pulse sequences for efficient mappings of T2, T2*, and T1 based on spiral acquisition and used them for iron assessment in different organs of the body. The highly significant linear correlations between relaximetry results and iron content are promising.

JAPANESE LANGUAGE SUMMARY SESSION
Basic Science Highlights
Room B-1  18:00 – 19:30

JAPANESE LANGUAGE SUMMARY SESSION
New Clinical Developments
Room B-2  18:00 – 19:30

MORNING CATEGORICAL COURSE
Functional Body MR: From Morphology to Function
Sakura  07:00 – 08:00 Chairs: Riccardo Manfredi and Carlo Bartolozzi

Educational Objectives
Upon completion of this course, participants should be able to:

• Evaluate new pulse sequences based on knowledge of current MR technique, and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Incorporate recent developments for MR imaging such as MRCP for the pancreas and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Apply new contrast agents in different hepatic diseases;
• Evaluate the possibility of MR imaging in bowel imaging and in screening oncologic patients for metastatic disease;
• Achieve functional information reflecting physiologic processes.

07:00  Kidneys
       Michael Pedersen

07:20  Uterus/Female Pelvis
       Kaori Togashi

07:40  Whole Body MRI
       Thomas Lauenstein
MORNING CATEGORICAL COURSE
Understanding Diffusion Imaging and Functional MRI: The Relationship between Structure and Function in the Brain
Room A 07:00 – 08:00 Chairs: Gareth J. Barker and R. Todd Constable

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain how the fMRI data are acquired and processed;
• Explain how the diffusion tensor is acquired, measured and mapped;
• Define the terms structural and functional connectivity;
• Describe sources of artifacts, limitations to the data, and the likely impact of new parallel imaging techniques on fMRI and DTI data;
• List methods available to combine the complementary information from fMRI and DTI data.

The final five minutes of each presentation will be reserved for questions.

Artifacts… and Correction Strategies
07:00 DTI
Christopher A. Clark
07:30 fMRI
Douglas C. Noll

MORNING CATEGORICAL COURSE
Echo Management
Room D 07:00 – 08:00 Chairs: Kim Butts and Scott D. Swanson

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain the basic principles of spin echo, gradient echo, and stimulated echo formation;
• Appreciate the complexity of coherence pathways that arise when two or more RF pulses are applied;
• Describe methods that investigators use to mitigate effects of multiple coherence pathways to assure formation of proper echoes;
• List techniques used in steady-state free precession (SSFP) pulse sequences to minimize spurious echo formation;
• Determine which sequence will be appropriate for what clinical application.

07:00 Gradient Recalled Echoes
Felix W. Wehrli
07:25 Advanced Gradient Echo Imaging
Samuel Patz
07:50 Discussion
MORNING CATEGORICAL COURSE
Established and Evolving Applications of MR Angiography

Annex 2 07:00 – 08:00 Chairs: J.F.M. Meaney, M.R. Prince, S.O. Schoenberg

Educational Objectives
Upon completion of this course, participants should be able to:
• Define the established indications for MRA;
• Recognize the importance of non-contrast and contrast-enhanced approaches in the different vascular territories;
• Diagnose common vascular pathology and variants;
• Apply the different post-processing algorithms to enhance diagnostic practice;
• Perform basic vessel wall imaging.

Peripheral MRA
07:00 Upper Extremity MRA
Klaus U. Wentz

07:20 Lower Extremity MRA
Tim Leiner

07:40 MR Venography
Stefan G. Ruehm

MORNING CATEGORICAL COURSE
New Horizons in Musculoskeletal Imaging: Optimizing MRI With Current Technology

Room B-1 07:00 – 08:00 Chairs: Joshua M. Farber and Lawrence M. White

Educational Objectives
Upon completion of this course, participants should be able to:
• Describe MR techniques for imaging cartilage at various field strengths and understand the clinical role of MRI in the evaluation of articular cartilage disorders;
• Assess the musculoskeletal system using high and low field MR systems;
• Explain and use fat suppression MRI techniques in the musculoskeletal system;
• Explain and use fast scanning MRI techniques in the musculoskeletal system;
• Apply knowledge of high resolution MRI, and its trade-off with signal-to-noise, to imaging the musculoskeletal system;
• Describe the rationale of protocol approaches and apply this understanding to optimize MRI clinical protocols.

07:00 High Field MRI of the Musculoskeletal System: Techniques, Protocol Optimization and Clinical Applications
Johannes Bloem

07:25 Mid-Low Field MRI of the Musculoskeletal System: Techniques, Protocol Optimization and Clinical Applications
Hiroshi Yoshioka

07:50 Discussion
MORNING CATEGORICAL COURSE
Parallel Imaging 2004

Annex 1 07:00 – 08:00 Chairs: Neil M. Rofsky and Daniel K. Sodickson

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain the basic principles of parallel imaging, including elements both of RF coil array design and image
  reconstruction;
• Critically survey promising applications of parallel MRI;
• Summarize recent research into the limits of performance of parallel imaging, describe new developments in image
  reconstruction and coil array design, and outline emerging parallel imaging applications;
• Identify the key steps in a practical parallel imaging examination, and compare the nuts-and-bolts features of various MR
  vendors' existing implementations.

Current Research
07:00 Recap of Basics and Applications
   Daniel K. Sodickson

07:05 Limits of Parallel MRI: Recent Results, Current Controversies
   Daniel K. Sodickson

07:20 New Developments in Image Reconstruction
   Jeffrey Tsao

07:40 New Developments in Array Design
   Jeff H. Duyn

MORNING CATEGORICAL COURSE
MR Spectroscopy: The Brain and Beyond

Room B-2 07:00 – 08:00 Chairs: Peter S. Allen, John R. Griffiths, Rolf Gruetter

Educational Objectives
Upon completion of this course, participants should be able to:
• Describe the principles of spectral analysis through LC modeling;
• Outline the mechanisms for intra-sequence signal loss when target metabolites have coupled spins;
• List the key metabolites facilitating the spectroscopic recognition of tumor development in the prostate and the brain;
• Outline how water can be used as an internal concentration standard with minimal associated spectral artifacts;
• Explain how macromolecular contamination of spectra can be recognized and mitigated;
• Explain how MRS can be used to reflect metabolic processes in muscle using glycogen or lipids.

07:00 Using Water as an Internal Standard
   Dieter Leibfritz

07:20 Discussion

07:30 Dealing with Macromolecular Signals
   Kevin L. Behar

07:50 Discussion
ANNOUNCEMENT OF YOUNG INVESTIGATOR AWARDS

Main Hall 08:00 – 08:15

FIRST ANNUAL SIR PETER MANSFIELD LECTURE

Main Hall 08:15 – 08:45 Chairs: Michael E. Moseley and Jeffrey L. Duerk

08:15 Title
Robert R. Edelman
Evanston Northwestern Healthcare, Evanston, Illinois, USA

PLENARY LECTURES
The Current and Future Role of Imaging in Cancer Therapy Assessment

Main Hall 08:45 – 10:00 Chairs: Kim Butts and Jeffrey L. Duerk

8:45 509. The Role of Imaging in the Assessment of Cancer Treatment
Anthony F. Shields1
1Wayne State University, Detroit, Michigan, USA

The tomographic imaging of anatomic structures, obtained with CT and MRI, has become an integral part of cancer treatment. While such anatomic images are clearly useful, they also have a number of limitations. Standard CT and MRI can measure the size of a tumor, but provide little information about its physiologic status. Newer imaging techniques such as DCE MRI, MR spectroscopy, and positron emission tomography produce images of physiology that provide an attractive means to measure response. These approaches are becoming more important in the development of targeted drugs and will become a standard part of routine therapeutic evaluation.

9:10 510. Current Concepts in MR Based Therapy Assessment
Michael V. Knopp1
1The Ohio State University, Columbus, Ohio, USA

Advances in therapeutics have led to increased clinical demand for accurate, effective, non-invasive assessment of therapies. Modern therapies require improved capabilities for early assessment as the socio-economic impact of ineffective therapies is high. MR has excellent capabilities in all three essential areas, the structural, functional and molecular assessment of response to therapy. Acquisition of large volumes of interest with adaptable resolution and high tissue contrast, combined with functional procedures such as perfusion and molecular techniques such as targeted agents and spectroscopy has brought MR based therapy response assessment into clinical drug development and patient management of advanced, elaborate therapies.

9:35 511. Molecular Imaging in Cancer Therapies of the Future
Chrit Moonen1
1University Victor Segalen, Bordeaux, France

The objective of Molecular Imaging (MI) is the multi-modality mapping of (patho)physiological and biochemical processes at the cellular and molecular level for diagnostics and therapy. MI will shift the emphasis of oncology towards prevention, early diagnostics and (minimally-invasive) molecular therapies. MRI requires amplification strategies to reach the sensitivity of optical and Nuclear Medicine techniques, but a large role in translational research can be envisaged. Challenges remain for future developments of MI in oncology research: 1) surrogate imaging markers; 2) specific contrast agents; 3) combined diagnostic/therapeutic agents; 4) image-guided technologies for local drug delivery and gene therapy.
fMRI Imaging Techniques

Main Hall  
10:30 - 12:30  
Chairs: R. Todd Constable and Douglas C. Noll

10:30  512.  fMRI With Intermolecular Double-Quantum Coherences (iDQC) at 3T  
Andreas Schäfer\(^1\), Thies H. Jochimsen\(^1\), Harald E. Möller\(^2\)  
\(^1\)Max Planck Institute of Cognitive Neuroscience, Leipzig, Germany

Common obstacles of functional magnetic resonance imaging (fMRI) studies are signal instabilities due to physiological and instrumental fluctuations. This is even pronounced for techniques exploiting intermolecular double-quantum coherences (iDQC) to generate functional contrast as the intrinsic signal-to-noise ratio (SNR) is substantially lower than in conventional gradient-recalled echo EPI. Aim of this work was to optimize SNR and functional contrast based on iDQC in order to achieve robust protocols for fMRI studies at 3 T. Experiments with a visual stimulation task was carried out in volunteers on two different scanners.

10:42  513.  Multiple Acquisitions with Global Inversion Cycling (MAGIC): A Multi-Slice Technique for Vascular-Space-Occupancy Dependent fMRI  
Hanzhang Lu\(^1\), Peter C. van Zijl\(^1\), Jeroen Hendrikse\(^2\), Xavier Golay\(^1\)  
\(^1\)Johns Hopkins University, Baltimore, Maryland, USA; \(^2\)University Medical Center, Utrecht, Netherlands

Recently a new fMRI technique, termed Vascular-Space-Occupancy (VASO), was introduced that uses T1-based blood nulling to detect cerebral blood volume (CBV) changes during brain activity. However, this technique is hampered by the fact that there is only one zero-crossing on the relaxation curve, presently limiting its application to single-slice studies. Here a multi-slice VASO-fMRI method is presented that employs a series of non-selective 180º pulses to periodically invert the magnetization and maintain it around zero, while acquiring slices in between. Multi-slice VASO-fMRI images of visual stimulation show effective blood nulling in all slices and appropriate functional activations in all volunteers.

10:54  514.  Effective Removal of fMRI Nyquist Artifact Using Temporal Domain Data Mixing / Filtering  
Nan-kuei Chen\(^1\), Seung-Schik Yoo\(^1\), Ying-hui Chou\(^2\), Koichi Oshio\(^1\), Lawrence P. Panych\(^1\)  
\(^1\)Brigham and Women's Hospital, Boston, Massachusetts, USA; \(^2\)Boston University, Boston, Massachusetts, USA

This article presents a novel approach for an effective removal of the Nyquist artifact in functional MRI. In the proposed method, echo-planar imaging (EPI) data at odd and even functional time points are acquired with opposite readout gradient polarities, and therefore the pattern of Nyquist artifact alternates during dynamic scans. The time-varying Nyquist artifact can then be removed with either temporal domain data mixing / filtering or conventional nonlinear phase correction. In comparison to previously reported nonlinear phase correction methods, Nyquist artifact correction through temporal domain data processing is more effective and requires a lower computation cost.

11:06  515.  Statistical Combination of Partial k-Space EPI for BOLD fMRI  
Christine S. Law\(^1\), Gary H. Glover\(^1\)  
\(^1\)Stanford University, Stanford, California, USA

We developed a technique to enhance BOLD fMRI activation by performing homodyne reconstruction separately on upper and lower halves of regular EPI data, forming two partial k-space images, which are then combined and weighted by their individual correlation coefficient maps. Activation in the combined upper/lower EPI images was compared to that from conventional full k-space reconstruction. Analogous to spiral in/out, statistically combined upper/lower EPI images show increased activation volumes over conventional EPI reconstruction. This improvement is due to elimination of correlated noise between the upper and lower images.

Alberto Vazquez\(^1\), Gregory Lee\(^1\), Luis Hernandez-Garcia\(^1\), Douglas Noll\(^1\)  
\(^1\)University of Michigan, Ann Arbor, Michigan, USA

A saturation-based approach is proposed to image dynamic changes in cerebral blood volume, particularly arterial blood volume, with good temporal and spatial resolution (AVIS - arterial volume imaging by saturation). The blood protons imaged are not restricted to the intravascular space making this technique also sensitive to tissue perfusion signal. A flow-suppression scheme demonstrated that these contributions are small. The amplitude of the AVIS signal change observed during motor activation was 34% (vs. 73% for FAIR). The temporal behavior of the AVIS signal resembled that of previously reported CBV measurements in rats.
11:30  **517. Prospective Real-Time Slice-by-Slice 3D Motion Correction for EPI Using an External Optical Motion Tracking System**
Maxim Zaitsev\(^1\), Christian Dold\(^2\), Jürgen Hennig\(^1\), Oliver Speck\(^1\)
\(^1\)University Hospital of Freiburg, Freiburg, Germany; \(^2\)Fraunhofer Gesellschaft, Darmstadt, Germany

The majority of the current prospective motion correction techniques for EPI time series are either image-based or they acquire position information using navigator scans. Image-based methods are only able to generate displacement information after a complete volume acquisition. Navigator-based approaches are more flexible, but increasing the number of navigators per volume inevitably slows down the acquisition. In this abstract the possibility of slice-by-slice 3D prospective motion correction of EPI time series without increasing the scanning time using an external optical motion tracking system is demonstrated.

11:42  **518. Single-Shot Susceptibility Insensitive Whole Brain 3D fMRI with ASL**
Guillaume Duhamel\(^1\), David C. Alsop\(^1\)
\(^1\)Harvard Medical School, Boston, Massachusetts, USA

Arterial Spin Labeling (ASL) may provide superior spatial resolution, better intersubject reproducibility, improved temporal stability, and reduced susceptibility artifact relative to BOLD for brain activation studies. Imaging approaches reported to date, however, have suffered from combinations of reduced slice coverage, image distortion or blurring at susceptibility boundaries and variable sensitivity across slices. Here we report a background suppressed, 3D fast spin echo ASL sequence which employs interleaved variable density spirals and parallel imaging to achieve imaging of the entire brain at under 4mm resolution in a single shot and its initial evaluation for fMRI of motor activation.

11:54  **519. Effects of Activation Induced Transit Time Changes on Functional Turbo ASL Imaging**
Gregory R. Lee\(^1\), Luis Hernandez-Garcia\(^1\), Douglas C. Noll\(^1\)
\(^1\)University of Michigan, Ann Arbor, Michigan, USA

Turbo ASL techniques allow functional scans at a higher temporal resolution and sensitivity than traditional ASL techniques, but are more sensitive to the transit time of the label to the imaging plane. The transit time changes that accompany functional activity can result in a wide variation in the relative signal changes observed for different choices of turbo ASL sequence timing. It is shown that optimal sensitivity and minimal distortion occurs for a choice of TR approximately 5-10% less than the resting state transit time.

12:06  **520. Shimming of the Inferior Frontal Cortex using an External Local Shim Coil**
Eric C. Wong\(^1\), Yousef Mazaheri\(^1\)
\(^1\)University of California, San Diego, La Jolla, California, USA

Susceptibility related magnetic field inhomogeneity in the inferior frontal cortex (IFC) can cause severe signal dropout and distortion in T2* weighted scans. To reduce field inhomogeneity in the IFC, passive and active intra-oral shims have been used with good effect. We introduce here the use of a small external local shim coil in front of the nose, which effects a similar recovery of signal in the IFC to that of intra-oral coils. The external coil allows for local shimming of the IFC without placing anything in the mouth of the subject, and preserves signal in the anterior temporal lobes.

12:18  **521. Doubling BOLD Signal in Auditory Cortex by Acoustic Modification of Echoplanar Sequence**
Klaus Scheffler\(^1\), Erich Seifritz\(^2\)
\(^1\)University of Basel, Basel, Switzerland

fMRI of the auditory system is impeded by scanner noise. Sequence and stimulation paradigm modifications can avoid stimulus-noise interactions. However, current approaches such as sparse sampling and silent sequences sacrifice temporal resolution and extract only static information from BOLD signals. Because pulsed but not unpulsed stimuli persistently excite auditory cortex, an fMRI sequence with quasi-continuous gradients producing continuous noise was developed. With this approach, spatio-temporal separability of BOLD responses to sounds systematically graded in several physical parameters dramatically improved.

**CLINICAL CATEGORICAL COURSE**
**Cardiovascular MR Imaging**


**Educational Objectives**
Upon completion of this course, participants should be able to:
- Describe basic areas of routine and promising clinical use of MR in assessing cardiovascular disease;
- Apply MR protocols for determination of cardiac morphology, dynamic function, flow, and physiologic status;
- Explain methodology that aids in the interpretation of results for cardiac MR assessment of acquired cardiac disease;
- Compare approaches for optimal presentation and analysis of cardiac MR results.
10:30 Valvular Disease  
Samuel A. Wickline

10:55 Perfusion  
Juerg Schwitter

11:20 Viability  
Joao A.C. Lima

11:45 Coronary Lumen and Vessel Wall  
Zahi A. Fayad

12:10 Discussion

12:30 Adjournment

Neuro Impairment

Annex 1  10:30 - 12:30  Chairs: Roland Kreis and Daniel M. Spielman

10:30  522. Prefrontal N-acetylaspartate:Creatine Ratio Predicts Functional Outcome Eighteen Months after a First Psychotic Episode  
Stephen J. Wood, Gregor Berger, Dennis Velakoulis, Philippe Conus, Geoff W. Stuart, Martin Lambert, Patrick D. McGorry, Patricia Desmond, Christos Pantelis  
1University of Melbourne, Melbourne, Victoria, Australia; 2Royal Melbourne Hospital, Melbourne, Victoria, Australia

Because the outcome of psychotic illness is highly variable, it is of great interest to be able to predict which patients will make a good recovery. MRS data from 39 patients were used to predict outcome 18 months after a first psychotic episode. While remission of psychosis was found to be dependant on baseline level of negative symptoms, both the number of inpatient admissions and global functioning at 18 months were predicted by baseline prefrontal NAA levels. This implies that patients with less intact prefrontal regions at first presentation are at greater risk for poor outcome.

10:42  523. Longitudinal Study of First-Episode Schizophrenia using 4.0T 1H MRS and Voxel-Based Morphometry  
Jean Théberge, Peter C. Williamson, Rahul Manchanda, Ravi S. Menon, Richard WJ Neufeld, Maria Densmore, Kathryn E. Williamson, Dick J. Drost  
1Lawson Health Research Institute, London, Ontario, Canada; 2University of Western Ontario, London, Ontario, Canada; 3Robarts Research Institute, London, Ontario, Canada; 4St-Joseph’s Health Care, London, Ontario, Canada

Previous reports have shown increased glutamate + glutamine in first-episode, never-treated schizophrenia patients and decreases in the same metabolites in chronic schizophrenia compared to controls in the left thalamus and anterior cingulate. Can progressive changes of glutamate, glutamine and grey matter volumes be observed in a longitudinal study of schizophrenia? Our new data shows decreases in thalamic glutamine + glutamate and creatine in a group of nine first-episode patients after 30 months of treatment compared to 10 months of treatment. Voxel-based morphometry showed significant decreases in grey matter volumes in areas functionally connected to the thalamus.

10:54  524. Selective Reduction of NAA in Medial Temporal Lobe in Mild Cognitive Impairment  
Norbert Schuff, Linda L. Chao, Joel H. Kramer, Bruce R. Reed, Du T. Antao, William J. Jagust, Helena C. Chui, Bruce L. Miller, Michael W. Weiner  
1VAMC & UCSF, San Francisco, California, USA; 2UC Davis, Davis, California, USA; 3UC Berkeley, Berkeley, California, USA; 4University of Southern California, Los Angeles, California, USA

The goal was to test whether elderly subjects with cognitive impairment but no dementia (CIND) present a regional pattern of diminished NAA that is similar to Alzheimer’s disease (AD). Seventeen CIND subjects were compared to 24 AD patients and 24 cognitively normal (CN) subjects. CIND had 20.1% (p = 0.005) less NAA in medial temporal lobe, including the hippocampus, than CN. Moreover, decreased NAA correlated stronger [r=0.59] with increasing memory deficits than hippocampal volume loss [r=0.29]. The results underscore the functional significance of reduced NAA in the brains of CIND subjects and its potential value for detecting early AD.
Amnestic Cognitive Impairment Correlates with Hippocampal Spectroscopy in Aged Human Brain
Julie W. Pan, Marcello Bial, Mindy Katz, Gail Kuziansky, Hoby P. Hetherington, Richard B. Lipton
1Albert Einstein College of Medicine, Bronx, New York, USA

Although it would be anticipated that hippocampal spectroscopy measurements are of interest for studies of amnestic cognitive impairment and aging, there are relatively few reports evaluating its use in correlation with neuropsychological performance. This may be surprising, given the success and more common use of hippocampal spectroscopy to evaluate temporal lobe epilepsy. We describe work correlating neuropsychological performance measures with hippocampal spectroscopy, finding significant lateralized relationships of NAA/Cr to assessments of language memory and dementia severity. None of these patients were diagnosed with Alzheimers’ disease; thus our findings suggest that hippocampal metabolic abnormalities can occur early with amnestic disability.

Proton Magnetic Resonance Spectroscopic Imaging in Mild Cognitive Impairment
Alena Horska, Cynthia Munro, Atilla Arslanoglu, Jason Brandt, Peter Barker
1Johns Hopkins University, Baltimore, Maryland, USA

Proton MRSI was applied to evaluate the extent of metabolic abnormalities and to identify brain regions with abnormal metabolism in MCI subjects. Although increasing age was associated with a decrease in average NAA/Cr and NA/Cho ratios, there were no differences in NAA/Cr, NAA/Cho and Cho/Cr (measured in 17 regions) between MCI and control groups. For both MCI and control subjects, lower verbal fluency (animals, supermarket) scores were associated with increasing white matter Cho/Cr. In the control group, several neuropsychological test scores were correlated with metabolite levels, whereas these correlations were not found in subjects with MCI.

Alzheimer and Other Dementias Diagnosis by 1H-MRS at Different Locations with Short and Medium Echo Times
M. Carmen Martinez-Bishal, Estanislao Arana, Beatriz Martinez-Granados, Enrique Molla, Luis Marti-Bonmati, Bernardo Celda
1Universitat de Valencia, Valencia, Spain; 2Clinica Quiron, Valencia, Spain

We studied the biochemical differences between Dementias and Depression in elderly by means of MRI and 1H MRS. 64 patients with cognitive impairment, age 69.5 ± 9.4 years: 31 patients with Alzheimer’s disease (AD), 18 with major depression, 9 presented mild cognitive impairment and 6 with vascular dementia. Demented subjects showed on TE 31 ms, Co/Cr and mI/Cr and lower levels on NAA/Cr with TE 136 ms and NAA/Co. mI/Cr and NAA/mI ratios were compared for discriminating between AD and the other three entities. NAA/mI ratio had the highest sensitivity (81.5%) and specificity (72.7%) with a value of 2.32.

Multi-Slice Echo Planar Spectroscopic Imaging Measures Pathology in Cerebral Cortex in Multiple Sclerosis
Henrik Kahr Mathiesen, Thomas Tscherning, Per Soelberg Sorensen, Olaf B. Paulson, Lars G. Hanson
1Copenhagen University Hospital Hvidovre, Hvidovre, Denmark; 2Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark

Post-mortem studies demonstrate cortical lesions in multiple sclerosis (MS), pathology not revealed on conventional MRI. Cortical metabolic changes and their correlation to disability is unknown in MS. Therefore, methods to evaluate these changes are wanted. Multi-slice echo planar spectroscopic imaging (EPSI) was performed on MS patients and healthy controls. A border of 1 cm at the surface of the cerebrum was selected for spectroscopic evaluation. Seven controls were rescanned within a week for validation. EPSI was shown to measure cortical metabolite ratios in a simple and reproducible way. We suggest the use of the presented technique in longitudinal studies.
Narcolepsy is a disabling neurological disease affecting approximately 1 in 2000 individuals and characterised by excessive daytime sleepiness (EDS), cataplexy, sleep paralysis, hypnagogic hallucinations, and disturbed nocturnal sleep. A dysfunction of the orexin (hypocretin) system in the hypothalamus has recently been linked to the pathogenesis of narcolepsy. We used 1H-MRS to look for evidence of neuro-degeneration in the hypothalamus of 23 patients with narcolepsy. A significant reduction in hypothalamic NAA/Cr in the patients compared to controls (p= 0.013) was detected. This neurochemical abnormality is direct evidence that hypothalamic neuronal loss is a central pathogenetic feature in narcolepsy.
A Study of the Spatial-Temporal Tradeoff in \( k-t \) BLAST Reconstruction

Michael Schacht Hansen\(^1\), Jeffrey Tsao\(^2\), Sebastian Kozerke\(^3\), Klaus Paul Pruessmann\(^2\), Peter Boesiger\(^2\), Erik Morre Pedersen\(^1\)

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\( k-t \) BLAST is a recently developed technique which allows high acceleration factors for dynamic imaging. The acceleration is achieved by optimized \( x-f \) space packing and by resolving any remaining aliasing in \( x-f \) space using prior knowledge from training data. In this study, we compared two ways of achieving a 5x scan-time reduction with simulation and in vivo experiments: A) a direct 5x acceleration and B) acquisition of 2.5x fewer time frames with 2x acceleration. The use of a higher acceleration factor (5x) was found to offer a more favorable tradeoff between spatial and temporal sampling, resulting in lower reconstruction error.

Integrated Real-Time MRI User-Interface

Jeff A. Stainsby\(^1\), Nick Hu\(^1\), Dingrong Yi\(^1\), Perry Radau\(^1\), Juan M. Santos\(^2\), Graham A. Wright\(^1\)

\(^1\)Sunnybrook & Women's College Health Sciences Centre, Toronto, Ontario, Canada; \(^2\)Stanford University, Stanford, California, USA

A framework for improved visualization and control for efficient and intuitive real-time MRI scan plane prescription is presented. A combination of a modular real-time scanning interface, 4D visualization tool of pre-acquired high resolution data and a novel 6 degree-of-freedom robotic arm provide an enhanced environment for real-time MRI.

A Rapid and Accurate Automated in-Vivo Shimming Application Integrated with the Siemens 1.5T and 3T Consoles

Jingmin Mo\(^1\), Virginie Callot\(^1\), Teng-Yi Huang\(^1\), Brigitte P. Poncelet\(^1\), Timothy Gordon Reese\(^1\)

\(^1\)Massachusetts General Hospital, Boston, Massachusetts, USA

Shimming is important for MR scans, especially at high field strength. A Windows based automated in-vivo shimming application using a symmetric-asymmetric spin echo EPI has been developed on our Siemens 1.5T (Sonata) and 3T (Trio) scanners. Preliminary evaluation in brain imaging has demonstrated its speed and accuracy, using 9 shim terms. One goal is to extend this application to cardiac shimming with ECG gating, using its short acquisition time. Its flexibility with free selection of shim terms also makes 3rd order and higher shimming possible. Another goal is to export the shimming application to our 7T scanner.

Optimizing SAR-Reduction for High-Field TSE with Asymmetric Hyperechoes Combined with Partial Fourier Parallel Imaging

Juergen Hennig\(^1\), Matthias Weigel\(^1\), Thorsten Thiel\(^2\)

\(^1\)University Hospital Freiburg, Freiburg, Germany; \(^2\)Bruker Medical, Ettlingen, Germany

SAR-reduction in TSE-sequences for high-field imaging has been performed by a combination of variable flip angles based on asymmetric hyperechoes (TRAPS) with incomplete k-space sampling using a combination of partial Fourier with parallel imaging (mSENSE and GRAPPA). It is demonstrated that the incremental benefit of incomplete sampling is about a factor of 2. A total SAR-reduction by a factor of 6-10 and more is therefore achievable without loss in SNR or image quality with appropriate flip angle modulation schemes. At higher reduction factors SNR and image quality start to suffer.

Implementation of High Flip Angle Fast Spin Echo Imaging at 4.7T without Exceeding Safety Limits: Application to Human Brain Imaging

David L. Thomas\(^1\), Enrico De Vita\(^1\), Steve Roberts\(^2\), Robert Turner\(^1\), Roger J. Ordidge\(^1\)

\(^1\)University College London, London, UK; \(^2\)MR Research Systems, Guildford, UK

Although high field systems can be beneficial to most MR imaging protocols, the acquisition of \( T_2 \)-weighted images at high field strength is only recently taking off. This is mainly due to the high power deposition associated with conventional Fast Spin Echo (FSE) imaging and the increased RF power requirements of high field systems. Whilst recent approaches have explored the potential of optimised low-flip angle FSE, here we show that appropriate choice of echo spacing and acquisition bandwidth, together with a simple modification to the k-space coverage, allows images with excellent quality to be obtained at 4.7T within safety limits.

High Temporal Resolution Breath-held 3D FIESTA CINE: Validation of Ventricular Function in Patients with Chronic Myocardial Infarction

Dan W. Rettmann\(^1\), Manojkumar Saranathan\(^1\), Katherine C. Wu\(^1\), Clerio F. Azevedo\(^2\), David A. Bluemke\(^2\), Thomas K. Foo\(^1\)

\(^1\)GE Medical Systems, Baltimore, Maryland, USA; \(^2\)Johns Hopkins University, Baltimore, Maryland, USA

Clinical evaluation of global cardiac function consumes a significant portion of the cardiac MRI exam time. A single breath-hold 3D FIESTA CINE sequence has been optimized for the clinical setting. The temporal resolution has been significantly increased by adding the ability to perform parallel imaging with 3D FIESTA CINE. Good correlations between a typical 2D CINE acquisition and the 3D CINE method were found in a chronic myocardial infarction patient population.
MR Imaging and Spectroscopy to Monitor Anti-Tumor Therapy

Annex 2  10:30 - 12:30  Chairs: Kazurom Sugimura and Martin O. Leach

10:30  **542. In Vivo Study of Anticancer Agent Temozolomide by [1H/13C] MRI/MRS**

Yoshinori Kato1, Baasil Okollie1, Zaver M. Bhujwalla1, Dmitri Artemov1
1The Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

One of the reasons for anticancer drugs failure is thought to be physiologic drug resistance or insufficient drug delivery to the tumor due to an inadequate tumor vascularization and/or anti-vascular effects of the chemotherapy. We studied intratumoral distribution of 13C-labeled anticancer agent temozolomide ([13C]TMZ) in mouse breast cancer models using in vivo MR spectroscopic imaging (CSI). Inverse 13C detection with heteronuclear multiple quantum coherence (HMQC) provided an optimum sensitivity of detection. Three-dimensional maps of drug distribution (2mm isotropic resolution) were obtained following intraperitoneal administration of [13C]TMZ. The status of the tumor blood supply was assessed by gadolinium enhanced dynamic MRI.

10:42  **543. Acute Tumour Response to ZD6126 Assessed by Intrinsic-Susceptibility Magnetic Resonance Imaging**

Simon P. Robinson1, Tammy L. Kalber1, Franklyn A. Howe1, Dominick JO McIntyre1, John R. Griffiths1, David C. Blakey1, Anderson J. Ryan1, John C. Waterton1
1St. George's Hospital Medical School, London, UK; 2AstraZeneca, Macclesfield, Cheshire, UK

Tumour R2* was measured prior to and either 35 minutes or 24 hours following administration of the vascular targeting drug ZD6126. A small yet significant increase in tumour R2* was measured 35 minutes after challenge, whereas a significant decrease in tumour R2* was found 24 hours after administration of ZD6126. Both responses were consistent with a decrease in tumour perfusion as measured by Hoechst 33342 uptake. A change in tumour R2* may provide an early imaging marker for detecting acute changes induced by vascular targeting agents.

10:54  **544. Quantification of VEGF Induced Permeability Changes by Multispectral Analysis**

Leanne Rae Berry1, Kai Barck1, Debra Dugger1, Simon Peter Williams1, Nicholas Van Bruggen1, Michael Ostland1, Hartmut Koeppen1, Ralph Harold Schwall1, Richard Alan Duray Carano1
1Genentech, Inc., South San Francisco, California, USA

In this study, a multispectral technique has been developed to extract and quantify regions of varying permeability and fractional plasma volume. The technique was employed to evaluate the response of 2 tumor lines (PC3 and Her2+) to VEGF administration and track changes in permeability. The data showed a decrease in regions of low permeability and high fractional plasma volume and trends towards an increase in regions of high permeability and low fractional plasma volume for the PC3 tumors.

11:06  **545. Time-Dependent Anti-Vascular Effects of ABT-751 Assessed by Dynamic Contrast Enhanced MRI**

Yanping Luo1, Vince Hradil1, Kurt Mohning1, Stephen Tahir1, David Frost1, Anne Hagey1, Saul Rosenberg1, Bryan Cox1
1Abbott Laboratories, Abbott Park, Illinois, USA

ABT-751 is a novel tubulin-binding agent that possesses potent anti-tumor and anti-vascular activities. The study focused on characterizing the time-dependent anti-vascular properties of ABT-751. Using dynamic contrast-enhanced MRI, ABT-751 induced perfusion changes were evaluated at 1 and 6 hours after the treatment. The corresponding effects on endothelial cell morphology were evaluated in vitro. Both in vivo and in vitro results confirmed potent, anti-vascular effects by ABT-751. However the decrease in tumor perfusion and the changes in endothelial morphology observed at 1 hour were transient, which were reversed at 6 hours.

11:18  **546. AZD2171 and ZD6474, VEGF Signalling Inhibitors, Significantly Reduce Tumour Vascular Permeability in a Human SW620 Xenograft as Detected by Macro-Molecular Dynamic Contrast Enhanced MRI**

Daniel P. Bradley1, Jean JT Tessier1, David R. Checkley1, Hitde Kurihayaishi1, John C. Waterton1, Steve R. Wedge1
1AstraZeneca, Macclesfield, UK

Anti-VEGF therapies are being avidly pursued as inhibitors of both tumour angiogenesis and VEGF dependent vascular permeability. Dynamic contrast enhanced MRI (DCE-MRI) with P792 was used to evaluate two VEGF signalling inhibitors in an acute treatment regime of a human colorectal xenograft. P792 is a gadolinium chelated rapid clearance blood pool contrast agent (RCPBA). A modified keyhole acquisition provided <500ms/image simultaneously acquiring both tumour enhancement and vascular input function. Both Vistarem uptake and permeability surface area product (PSP) greatly decreased after treatment. These data suggest a RCBPA DCEMRI protocol can assess treatments perturbing vascular components of the tumour.
11:30 547. Modelled Temporal Responses of Tumor Volume and ADC to Anticancer Therapy

Thomas L. Chenevert¹, Bradley E. Layton², Robert C. Welsh¹, Surabhi Sharma¹, Brian D. Ross¹
¹University of Michigan, Ann Arbor, Michigan, USA; ²Drexel University, Philadelphia, Pennsylvania, USA

This study investigates the temporal relationship between tumor volume and ADC following therapy using a model of tumor growth, therapeutic action, lysis and water clearance. The model was applied to tumor volume and ADC measured on 9L glioma rats treated with BCNU, and brain tumor patients. The model yields estimates of relative amplitude and duration of therapeutic action, necrosis production and clearance. In single-dose treatment of animals, the degree of therapeutic response increased with dose amount. In protracted multi-dose schemes, however, the duration of effective therapeutic action did not scale with duration of therapy delivery suggesting therapy resistance.

11:42 548. Increases in Apparent Diffusion Coefficient Following Therapy are Correlated with Region-Specific Cell Death

David L. Morse¹, Jean P. Galons¹, Dominique Jennings¹, Claire M. Payne¹, Sam Day¹, Robert J. Gillies¹
¹University of Arizona, Tucson, Arizona, USA

MRI-measured apparent diffusion coefficient of water (ADCw) increases early in response to cancer therapies. Since cell death by apoptosis occurs early and involves cell shrinkage, it has been suggested that increased diffusion is a surrogate for apoptosis. However, other early modes of death can occur involving changes in the intra- and extracellular volumes. We examined ADCw changes in response to therapies inducing cell death by mechanisms other than apoptosis. Our data suggests that early changes in ADCw occur in concert with mitotic catastrophe and lytic necrosis, suggesting that other mechanisms besides cell shrinkage may mediate the MR-measured ADCw changes.

11:54 549. Apparent Diffusion Coefficient Changes in Areas of Prostatic Necrosis Following Photodynamic Therapy in Patients with Local Recurrence of Prostate Cancer

Masoom A. Haider¹, Zhaohue Zhang¹, Igor Sitarchouk¹, Timothy P. Roberts¹, Mark R. Gertner², Arjen Bogaards³, Avigdor Scherz³, Yoram Salomon³, Patrick Cohen³, Brian C. Wilson³, John Trachtenberg³
¹University Health Network - Mount Sinai Hospital, University of Toronto, Toronto, Ontario, Canada; ²Ontario Cancer Institute; Princess Margaret Hospital, University Health Network, Toronto, Ontario, Canada; ³Weizmann Institute of Science, Rehovot, Israel; ⁴Negma-Lerads, Toussus-Le-Noble, France

Photodynamic therapy (PDT) with WST09 (TOOKAD) is a novel method for treating prostate cancer. The purpose of this study was to determine the change in ADC after WST09 PDT in areas of prostatic necrosis in patients with recurrent prostate cancer post-radiation. Necrosis was present in 10/28 prostate halves 7 days post PDT. All necrotic areas showed a negative ∆ADC. ADC post-therapy was lower than ADC pre-therapy (p<0.005). Although one might expect increased free water in areas of necrosis, ADC drops post WST09 PDT. WST09 PDT is known to produce coagulative as opposed to liquefactive necrosis possibly explaining low ADC values.

12:06 550. Magnetic Resonance Imaging Follow-Up after Percutaneous Radiofrequency Ablation of Renal Cell Cancer: Short- and Midterm Imaging Findings in Eighteen Consecutive Patients

Elmar Merkle¹, Sherif Nour², Jonathan S. Lewin²
¹Duke University Medical Center, Durham, North Carolina, USA; ²Case Western Reserve University, Cleveland, Ohio, USA

The purpose of this study is to evaluate the MR findings after thermal ablation of renal cell cancer. In conclusion, Renal RF thermal lesions follow the same pattern as hepatic RF thermal lesions in terms of temporal evolution of lesion size. After an initial growth within the first two weeks, shrinkage is observed in the further course of follow up. While signal characteristics on T2w imaging are the same as in the liver after RF thermal treatment (both appear hypointense), RF lesion appearance is different on T1w images where lesions are much brighter than in the liver.

12:18 551. Absolute Choline Concentration in ¹H MR Spectroscopy and Diffusion-Weighted MR Imaging at 3.0T for the Diagnosis and Monitoring of Therapeutic Effect of Hepatocellular Carcinoma Before and After Chemo

ChiaoYun Chen¹, Gin-Chung Liu¹, TweiShiun Jau¹, ChunWei Li²
¹Kaohsiung Medical University Chung-Ho Memorial Hospital, Kaohsiung, Taiwan; ²Kaohsiung Medical University, Kaohsiung, Taiwan

To evaluate the diagnosis and therapeutic effect of patients with large Hepatocellular carcinoma (HCC) before and after transarterial chemoembolization (TACE) by absolute choline concentration on 1H MRS and the ADC value with DWMR images. Absolute choline concentration on 1H MRS and DWMR image could be useful methods for diagnosis and monitoring the therapeutic response to TACE for HCC.
Flow Quantification and Vessel Wall Function

Room D  10:30 - 12:30  Chairs: David N. Firmin and Norbert J. Pelc

10:30  552.  Investigation of Eddy Current Effect on Phase Contrast Imaging
Yong Zhou¹, Steven D. Wolff¹, Thomas M. Grisl³, Jason A. Polzin¹
¹GE Medical Systems, Waukesha, Wisconsin, USA; ³Cardiovascular Research Foundation, New York, New York, USA; ¹University of Wisconsin-Madison, Madison, Wisconsin, USA

We introduce a theoretical model and a testing procedure that can be used to identify the relationship between the error in phase contrast (PC) measurements and the eddy currents of the system. The results show that for typical clinical protocols the phase error is very sensitive to the eddy current with time constant on the order of the echo time (TE). The sensitivity drops significantly for eddy currents with very short or very long time constant.

10:42  553.  Time Efficient Method for Dual-Venc Blood Velocity Measurements
Eugene G. Khomovski¹, Dennis L. Parker¹
¹University of Utah, Salt Lake City, Utah, USA

There are several trade-offs in the selection of parameters for PC-MRA velocity measurements. Velocity encoding (Venc) must be large enough to prevent phase aliasing yet as small as possible to maximize measurement accuracy. In cases when blood velocity distribution covers a wide range of velocities it is preferable to acquire sets of images with low and high Vencs to satisfy these requirements. A novel method to improve time efficiency of dual-Venc velocity imaging has been developed. The proposed method requires only 4 velocity encoded measurements rather than 7 measurements needed for the standard dual-Venc technique to reconstruct 3D velocity map.

10:54  554.  PC VIPR: Time-resolved 3D Undersampling Phase Contrast
Tianliang Gu¹, Frank R. Korosec¹, Thomas M. Grisl¹, Walter F. Block¹, Sean B. Fain¹, Charles A. Mistretta¹
¹University of Wisconsin - Madison, Madison, Wisconsin, USA

Due to the high acceleration factors provided by VIPR, PC VIPR has the potential to provide high-resolution anatomical information and quantitative flow information in times comparable to 3D TOF. In this abstract we focus on the ability of gated PC VIPR to retrospectively provide flow waveforms at any location in the imaging field of view (FOV). In-vivo flow measurements obtained with time-resolved PC VIPR were validated using 2D cine PC.

11:06  555.  In Vivo Time Resolved Measurement of Vessel Wall Strain of the Ascending Aorta in Mice at 17.6T
Volker Herold¹, Philipp Mörchel¹, Cornelius Faber¹, Axel Haase¹, Peter Michael Jakob¹
¹University of Würzburg, Würzburg, Bayern, Germany

Characterization of arterial wall motion and strain provides a direct measure of the function and viability of the vascular system. Mouse models are increasingly used in basic research to investigate the functional consequences of gene-manipulation. We present a noninvasive black blood phase contrast subtraction method, which allows temporal and spatial resolved strain measurement of the ascending aorta in mice. Since vessel wall radius were not calculated by spatial data, but by velocity data sub pixel displacements could be detected allowing for a higher accuracy in strain calculations.

Maria del Carmen Lorenzo-Valdes², Gerardo Ivar Sanchez-Ortiz², Hugo Bogren², Raad Mohiaddin², Daniel Rueckert¹
¹Imperial College, London, UK; ²Royal Brompton Hospital, London, UK

A method for the estimation of areas in 2D MR images of the aorta is presented. It uses spatio-temporal non-rigid registration in order to align all time frames in the image sequence simultaneously to the first one to obtain the 2D deformation fields of the vessels during the cardiac cycle. The determinants of the Jacobian of the deformation fields in a selected region of interest are computed to obtain the expansion/contraction with respect to the first time frame. Experiments are presented in 6 data sets and results are compared with areas estimated manually where the average error is 2%.

11:30  557.  In Vivo Blood Flow Characteristics in the Proximal Pulmonary Arteries of Healthy Children and Adults at Seated Rest and During Cycling Exercise
Christopher P. Cheng¹, Robert J. Herfkens¹, Charles A. Taylor¹, Jeffrey A. Feinstein¹
¹Stanford University, Stanford, California, USA

Description of pulmonary flow characteristics at rest and during exercise in healthy subjects may aid in the assessment of pulmonary flow abnormalities. Mean flow and flow reversal in the proximal pulmonary arteries (PA) were measured in children aged 10-13 years and adults aged 20-30 at rest and exercise using a custom MR-compatible exercise-cycle in a GE 0.5T interventional-magnet. For both groups, mean flow increased similarly and flow regurgitation appears to originate from the left PA at rest and exercise. Adults were observed to have more balanced flow distribution to the two lungs and greater regurgitation at rest.
**Detection and Quantification of Pulmonary Arterial Hypertension caused by Increased Pulmonary Resistance using MR Flow Measurements**

Nasreddin D. Abolmaali1, Thomas Wolf1, Hans-Georg Posselt2, Christina Smaczny3, Frank Bretz4, Thomas J. Vogl5

1JW Goethe University, Frankfurt am Main, Germany; 2Pediatric Medicine, Frankfurt am Main, Germany; 3Department for Pulmonology and Allergology, Frankfurt am Main, Germany; 4University of Hannover, Hannover, Germany

MR flow measurements (MRvenc; temporal resolution:<10ms) were evaluated to detect pulmonary arterial hypertension (PAH) in patients suffering from cystic fibrosis (CF). 48 patients and 48 age-matched healthy volunteers were examined. Pulmonary arterial pressure (PAP) was quantified. In healthy subjects the mean acceleration time (AT) and the mean systolic flow velocity (MV) were not significantly different from the CF-patients (healthy: AT=136ms±13, MV=66cm/s±13; CF: AT=127ms±21, MV=59cm/s±12). Five CF-patients revealed significantly lower values for AT (81ms±14) and MV (46cm/s±11) with elevated PAP (25-36mmHg) while PAP was <20mmHg in all other subjects. MRvenc is capable to detect and quantify the development of a PAH.

**A Novel Non-Invasive Method of Pulmonary Vascular Resistance Quantification**

Vivek Muthurangu1, Maxime Sermesant1, Andrew Taylor1, Derek Hill1, Reza Razavi1

1Kings College London, London, UK

We describe a non-invasive method of quantifying PVR using pulmonary blood flow curves as an input to a windkessel model. We demonstrate the accuracy of this technique and show its use in quantifying the change in PVR with nitric oxide.

**Estimation of Local and Regional Bolus Velocities using Whole Body Functional MR Imaging**

Ananth Jayaseelan Madhuranthakam1, Houchun Harry Hu2, David G. Kruger3, Erik A. Rohde1, James F. Glockner1, Andrew Taylor1, Derek Hill1, Reza Razavi1

1Mayo Clinic College of Medicine, Rochester, Minnesota, USA

A 3D time-resolved continuously moving table technique was previously demonstrated to track the leading edge of a contrast bolus in real-time. In this work these data sets were analyzed to provide functional information such as localized bolus velocities over the extended FOV. Contrast arrival times were estimated on a pixel-by-pixel basis and plotted against longitudinal position (S/I). Regional slopes and differentiation of this position versus time curve provide regional and local bolus velocities, respectively. A consistent reduction in velocity was observed as the bolus moves distally. This information will be useful to guide the table motion for non-time-resolved peripheral MRA.

**Regional Measurement of Skeletal Muscle Blood Flow During Post-Ischemic Reactive Hyperemia**

Richard B. Thompson1, Ronnier Aviles1, Venkatesh K. Raman1, Anthony Z. Faranesh1, Robert S. Balaban1, Elliot R. McVeigh1, Robert J. Lederman1

1National Institutes of Health, Bethesda, Maryland, USA

First-pass contrast-enhanced (Gd-DTPA) perfusion methods were adapted for the measurement of skeletal-muscle blood flow. Perfusion studies were carried out during a period of post-ischemic reactive hyperemia following a 5 minute arterial occlusion. A novel contrast delivery method provides a step-input of tracer concentration that is coincident with the onset of hyperemic flow which allows simple evaluation of the unidirectional influx constant, Kᵣ, and the fractional distribution volume, vᵣ, without the need for deconvolution with a measured arterial input function. Flow (Kᵣ) is shown to vary significantly between calf muscle groups in normal volunteers and patients with peripheral artery disease.

**Functional Renal MR Imaging**

Room B-1  10:30 - 12:30   Chairs: Stefan O. Schoenberg and P.V. Prasad

**Intra-Renal BOLD MRI at 3.0T: Evaluation of Voxel Size Dependence and Utility of ASSET**

Lu-Ping Li1, Belinda SY Li2, Eugene Dunkle1, Linda Pierchala1, Pottumarthi V. Prasad2

1Evanston Northwestern Healthcare, Evanston, Illinois, USA; 2GE Medical Systems, Evanston, Illinois, USA

We had previously shown that renal medullary R₂⁺ is higher at 3.0T. High-field strength also improves spatial resolution, and thereby reducing partial volume effects. Compared to 256x256 matrix size, our data shows that the R₂⁺ is significantly reduced at 512x512. However, with 128x128 matrix size, there was no significant change in the R₂⁺ values, probably due to compensatory partial volume effects. The surprising result is that with ASSET the R₂⁺ at 512x512 was comparable to that at 256x256. We also show that with 128x128 matrix size and using ASSET, we could obtain whole kidney coverage within a single breath-hold.
10:42 563. **Quantification of Renal R₂⁺ Index using BOLD-MRI: Reproducibility and Observation of Age-Dependence**

*Sonia Zoula¹, Lucie Hofmann¹, Andreas Giger¹, Bruno Vogl¹, Peter Vock¹, Felix J. Frey¹, Chris Boesch¹*

¹University and Inselspital, Bern, Switzerland

Reproducibility, robustness, and age-dependence of BOLD measurements in human kidney are evaluated. Three identical measurements (1.5T; MEDIC sequence; TR: 65ms; TE: 6-52.31ms; flip angle: 30°) were performed on 3 axial and 3 coronal slices of right and left kidneys in 11 volunteers. The mean values of R₂⁺ determined in medulla and cortex showed that BOLD measurements in the kidney are highly reproducible and confirm the cortico-medullary gradient of the BOLD effect; however, age-dependence and a tendency to increased values with time in the magnet should be considered when studying BOLD measurements in the kidney.

10:54 564. **Detection of Acute Renal Ischemia in a Swine Model with BOLD MR Imaging**

*Sara K. Alford¹, Jason A. Polzin², Orhan Unal¹, Daniel W. Consigny¹, Frank R. Korosec¹, Thomas M. Grist¹*

¹University of Wisconsin - Madison, Madison, Wisconsin, USA; ²GE Medical Systems, Milwaukee, Wisconsin, USA

Blood oxygen level dependent (BOLD) MR imaging can provide information on renal function by measuring intrarenal oxygenation through the spin-spin relaxation rate, R₂⁺. The objective of this study is to assess the potential of BOLD MR imaging to detect acute renal ischemia. BOLD MR imaging was performed on five swine prior to and during occlusion of the renal artery. Occluded R₂⁺ measurements from the cortex and medulla displayed a significant difference when compared to the initial R₂⁺ measurements. This study demonstrated that BOLD MR imaging could be used as a means to detect acute ischemia in a swine model.

11:06 565. **Effect of Nitric Oxide Inhibitor on Intra-Renal R₂⁺ Measurements in Humans**

*Lu-Ping Li¹, Eugene Dunkle¹, Linda Pierchala¹, Pottumarthi V. Prasad¹*

¹Evanston Northwestern Healthcare, Evanston, Illinois, USA

The underlying hypothesis that motivated us to perform this study is that subjects predisposed to development of hypertension will show reduced R₂⁺ response with nitric oxide (NO) inhibition. We had previously demonstrated that NO inhibitors reduced renal medullary R₂⁺ in normotensive, but not hypertensive rats. We present here for the first time the renal medullary R₂⁺ response to the administration of NO inhibitor (L-NMMA) in healthy human subjects using BOLD MRI technique. The R₂⁺ in the renal medulla showed a small but significant increase (30.6±2.2 to 33.9±2.6, p < 0.05 by paired Student’s t-test) after administration of L-NMMA.

11:18 566. **Quantitative Dynamic MRI using Contrast Media in Renal Failure**

*Nicolas Michoux¹, Xavier Montet¹, Antoinette Pechere², Alain Keller², Francois Terrier², Jean-Paul Vallée²*

¹University Hospital of Geneva, Geneva, Switzerland

Using dynamic Gd-DTPA contrast enhanced MRI, renal outflow curves are compared in normal and renal failure patients quantitatively. After a flow-corrected calibration, the upslope method is applied to measure absolute blood flow and times to peak. In case of renal failure, there is a significant decrease in the cortical and medullary perfusion as well as in the contrast agent accumulation in the medulla, and a trend in the reduction of the relative cortical to medullary perfusion indicating some compensatory mechanisms which remain to be investigated. Using quantitative models, dynamic MRI shows a strong potential for quantifying renal failure.

11:30 567. **Diffusion Weighted Imaging in the Assessment of Renal Dysfunction**

*Lawrence C. Chow³, Ruby Chang³, Roland Bammer³*

³Stanford University School of Medicine, Stanford, California, USA

The relationship between ADC values and renal failure was evaluated by comparing renal ADC values obtained with ssEPI DWI with serum creatinine levels in patients with normal and abnormal renal function. There was a significant decrease in renal ADC in patients with renal insufficiency and a linear correlation between renal ADC and serum creatinine in patients without unilateral disease. There was a striking difference in ADCs between normal and compromised kidneys in patients with unilateral renal disease. These results suggest potential utility in evaluating patients with renal dysfunction.

11:42 568. **Deconvolution-Based MR Imaging of Renal Perfusion and Function using Dynamic T₁ Contrast: A Feasibility Study**

*Martine Dujardin¹, Steven Sourbron¹, Peter Van Schuerbeeck¹, Rob Luypaert¹, Michel Ostéaux¹*

¹Free University of Brussels, Brussels, Belgium

The objective of this study was to investigate whether deconvolution of T₁-DCE data on a pixel-by-pixel basis in the kidney leads to acceptable regional parameters and data of diagnostic quality. Data were evaluated by comparison to parametric maps calculated prior to deconvolution. Our findings show that amplification of noise by deconvolution has a negligible impact on image quality and that deconvolution leads to improved delineation of anatomical structures. Quantitatively, cortical/medullar perfusion ratio and single kidney glomerular filtration are within normal range. Absolute perfusion values are underestimated, which indicates the necessity for refinement of the method.
A method for semiquantitative MR measurements of renal perfusion is presented. Using a SR-TurboFLASH sequence with a high temporal resolution arrival and wash out of the contrast agent was analyzed in 89 kidneys with suspected renal artery stenosis. The yielding parameters mean transit time and time to peak signal intensity showed significant differences between healthy kidneys and those with high-grade renal artery stenosis.

A dual-contrast-agent method for imaging renal pH has been developed. Two contrast agents, Gd-DOTP and Gd-DOTA-4AmP, are employed. Potential artifacts in the calculated pH maps are discussed. Empirical strategies for correcting for these errors are presented.

Tissue Characterization with Elastography and Microscopy

Room B-2  10:30 - 12:30    Chairs: Joseph A. Helpern and Armando Manduca

10:30  572.  Improved Phase to Noise Ratio for Short T2* Spins in MRE
Roger C. Grimm1, Jennifer L. Kugel1, Richard L. Ehman1
1Mayo Clinic, Rochester, Minnesota, USA

The application of the motion sensitizing gradients in MR Elastography extends the minimum achievable TE and makes imaging short T2* spins challenging. We introduce a novel pulse sequence, MRE-echo train, that uses the motion sensitizing gradients as read gradients. Imaging along the echo train allows acquisition of the signal earlier in the signal decay process. This paper examines the phase to noise of this new sequence compared to a standard MRE sequence. The MRE-echo train sequence has superior phase to noise for scans of short T2* spins or scans with a high number of motion sensitizing gradients.

10:42  573.  2D Non-Linear MR Elastography - Preliminary Results
Uwe Hamhaber1, Jürgen Braun1, Sebastian Papazoglou1, Egbert Gedat1, Matthias Taupitz1, Donald B. Plewes2, Ingolf Sack1
1Charité, Berlin, Germany; 2Sunnybrook and Women's, University of Toronto, Toronto, Ontario, Canada

In MR Elastography (MRE) tissue vibrations are determined for evaluating the shear stiffness of soft tissues in terms of local wavelengths. Beyond the linear stress-strain response of materials, their non-linear elastic behavior is of special interest for characterizing biological tissue. Here, a method is proposed to image spatially resolved non-linear wave propagation in MRE. The technique relies on the detection of higher harmonic vibrations, at a multiple of the fundamental frequency. These frequencies are selected by specific oscillating gradients and evaluated for their spatial amplitude functions. Potential applications for 2D mapping of non-linear elastic coefficients of in-vivo tissues are discussed.

10:54  574.  Transient-Based MR Elastography of the Brain
Paul James McCracken1, Armando Manduca1, Joel P. Felmlee1, Richard L. Ehman1
1Mayo Clinic and Foundation, Rochester, Minnesota, USA

Mechanical transients have been used to model traumatic brain injury, but there is still debate about the underlying material properties of the in-vivo human brain, which are often used in mathematical simulations of traumatic brain injury. A mechanical transient-based MRE method is used to interrogate the material properties of the brain in a healthy volunteer. The resulting elastogram matches well with anatomy and may prove helpful in traumatic brain injury modeling, diffuse disease analysis, and possibly complement fiber tract studies.

11:06  575.  Micro-Magnetic Resonance Elastography (µMRE)
Shadi F. Othman1, Huihui Xu1, Richard Magin1
1University of Illinois at Chicago, Chicago, Illinois, USA

Conventional MR-Elastography (MRE) is conducted at 1.5T in typical FOV of 20cm with in-plane resolution of 1x1mm and a slice thickness of 5mm. In this study at 11.74T, we develop µMRE with FOV<2cm, in-plane resolution<150x150µm, and a slice thickness<0.5mm. The imaging voxel is at least three orders of magnitudes smaller than that used in MRE. To verify the method, shear wave images in gel phantom were obtained at a mechanical excitation frequency of 570Hz. Preliminary studies using articular cartilage and frog oocyte demonstrated that this technique has the potential for investigating biological samples at sub-millimeter scale.
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Sang-Pil Lee¹, Maria Fatima Falangola¹, Ralph A. Nixon¹, Karen Duff¹, Joseph A. Helpern¹  
¹The Nathan Kline Institute, Orangeburg, New York, USA |

The visualization of the β-amyloid plaque deposition in the brain, a key feature of Alzheimer’s disease (AD), is important for understanding the pathogenic progression of the disease as well as treatment efficacy. In this study, we demonstrate clear detection of β-amyloid plaques in various regions of the fixed PS/APP transgenic mouse brain using MR microscopy without any contrast reagents. The plaques identified in the MRI were in good agreement with those in the immunohistochemical analysis of the same brain sections. With optimized MR microscopy, the total scan time was reduced to approach reasonable times for in vivo imaging.

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| 11:30 | 577. **High-Resolution Magnetic Resonance Imaging of β-amyloid Plaques in Transgenic Mice**  
Cheuk Ying Tang¹, Gilberto Juan Aguinaldo¹, Arash Hajianpour¹, Lap Ho¹, Zhongming Zhang¹, Thomas Wisniewski¹, Patrick Hof¹, John Morisson¹, Daniel Perl¹, Giulio Passinetti¹  
¹Mt. Sinai School of Medicine, New York, New York USA; ²New York University, New York, New York, USA |

In this project we propose to use T2-weighted micro MRI to obtain whole brain measures of beta-Amyloid burden in transgenic mice models of Alzheimer's disease. Whole brain images are obtained at 20 and 25 micron isotropic resolution with beta-amyloid plaques shown as hypointense lesions. Imaging times can be shortened with the use of T-relaxation shortening agents such as Gadolinium based contrast agents without much interference with the inherent contrast of the specimen. The resulting volumetric data is in a digital form readily suitable for subsequent computerized whole brain plaque quantification.

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| 11:42 | 578. **Longitudinal Study of Early Xenopus Embryonic Development using 3D-Microscopic MRI**  
Cyrus Papan¹, Benoit Boulat¹, Scott E. Fraser¹, Russell E. Jacobs¹  
¹California Institute of Technology, Pasadena, California, USA |

Studies focusing on the amphibian morphogenesis and tissue relationships are hampered by the optical opacity of their early embryos. Consequently, observations about embryo morphogenesis remain indirect interpretations that rely on either fixed and sectioned material or on tissue explants. To directly examine the development of Xenopus embryo, we are using microscopic magnetic resonance imaging (µMRI). The initial feasibility of the technique has been demonstrated earlier (Jacobs and Fraser, Science 263 (5147), 1994). Here we explore the method in greater detail and apply it for the live examination of early Xenopus development in a true 3D time lapse analysis.

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| 12:06 | 580. **Paraformaldehyde and Karnovsky’s Fixatives Alter Microstructure in an Erythrocyte Ghosts Tissue Model**  
Timothy M. Shepherd¹, Peter E. Thelwall¹, Greg J. Stanisz¹, Stephen J. Blackband¹  
¹University of Florida, Gainesville, Florida, USA; ²Sunnybrook/University of Toronto, North York, Ontario, Canada |

High resolution MRI investigations often resort to fixed tissue specimens to allow significantly longer scan times without motion artifacts. However, little is understood about how chemical fixatives alter the tissue microstructure underlying MRI contrast mechanisms such as diffusion. We report the effects of two commonly employed fixatives (4% paraformaldehyde and a modified Karnovsky’s solution) on a simplified tissue model made of erythrocyte ghosts. The results indicate fixative-dependent differences in water exchange between the intra- and extracellular compartments. Researchers should be cautioned when interpreting data from fixed tissue.

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| 12:18 | 581. **Observation of B1 Field Focusing in Small Homogeneous Phantoms and Biological Samples at 17.6 T**  
Xavier Helluy¹, Andrew Webb¹  
¹University of Würzburg, Würzburg, Bavaria, Germany |

¹H high resolution NMR spectroscopy and MR microscopy experiments at 750 MHz (17.6 T) correspond to an RF wavelength of ~4.5 cm in water (dielectric constant ε=80). Consequently, NMR spectroscopy of water-based samples (5-10 mm diameter) and MR microscopy of fixed and in vivo biological samples can be affected by significant B1 field inhomogeneities due to dielectric field focusing. Here we quantify B1 field focusing at 750 MHz in gradient-echo images of phantoms and in vivo rat brain and conclude that dielectric effects are strong for samples in polar solvents but moderate for in vivo applications in small animals.
Thursday PM

GOLD CORPORATE MEMBER LUNCHEON SYMPOSIUM
Berlex Imaging/Schering AG
The New Wave in Contrast-Enhanced MRI

Main Hall 12:30 – 13:30 Chair: Yutaka Imai

Comprehensive Vascular Evaluation with MS-325: The Future in Diagnostic Imaging
Thomas M. Grist, M.D., University of Wisconsin, Madison, Wisconsin, USA

“One-Stop Shop” Contrast-Enhanced Cardiac MR Study Including Whole-Heart Coronary MRA
Hajime Sakuma, M.D., Mie University School of Medicine, Mie, Japan

BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)
Parallel Imaging: Reconstruction Methods and Regularization

Please see page for details.

CLINICAL SCIENCE FOCUS SESSION
DTI, fMRI, and Volumetrics in Pediatric Brain
Sakura 13:30 - 15:30 Chairs: David G. Gadian and Petra A. Hüppi

13:30 582. Diffusion Tensor Imaging using SENSE in Prenatal Studies
Paola Scifo1, Cristina Baldoli1, Andrea Righini2, Silvia Pontesilli1, Arnaud Cachia1, Jessica Dubois1, Denis Le Bihan1, Giuseppe Scotti1, Ferruccio Fazio1
1Istituto Scientifico H San Raffaele, Milan, Italy; 2Children Hospital V. Buzzi, Milan, Italy
In this work, we show the preliminary results of prenatal studies using DTI and parallel imaging. The combination of these two techniques enables to have breath-hold compatible acquisition time and thus to reduce movement artefacts related to mother's respiration. Tensor maps (such as D and FA) have been calculated and quantification have been performed in various brain regions. FA and D are compatible with premyelination anisotropy and with the values reported in literature regarding pre-term children

13:40 583. Quantitative Volumetric MR Imaging Analysis to Assess the Effect of Prematurity and White Matter Injury on Neonate Brain Development
Terrie E. Inder1, Deanne K. Thompson2, Masa Pavlovic2, Hong X. Wang2, Rod W. Hunt1, Simon K. Warfield3, Gary F. Egan2
1Royal Children's Hospital, Melbourne, Victoria, Australia; 2Howard Florey Institute, Melbourne, Victoria, Australia; 3Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA
MR imaging and volumetric analysis techniques were used to quantitatively measure cerebral tissue volumes within the preterm brain. The premature infant demonstrated significant alterations in brain structure on quantitative MRI by term equivalent. The effect of birth weight, gestational age, gender and degree of white matter injury on premature infant brain development was investigated. Regional volumetric analysis of brain images was carried out in order to determine the regional variations of cerebral tissue types and severity of white matter injury. Preterm infants demonstrated maximal reduction in gray matter and myelinated WM in the sensory motor and occipital regions.

13:50 584. A 3D Volumetric Study: Development of the Hippocampus in Newborns with Intrauterine Growth Restriction
Gregory Lodygensky1, Slava Zimine1, Marianne Gex-Fabry1, Francois Lazeyras1, Simon K Warfield2, Petra S Hüppi2
1University Hospital of Geneva, Geneva, Switzerland; 2Brigham and Woman's Hospital, Boston, Massachusetts, USA
3D MR image analysis was used in this study to assess the effects of adverse fetal environment on early human brain development. To determine the effect of intrauterine growth restriction (IUGR) on brain development in preterm infants, we assessed the hippocampal volume, as a structure of particular vulnerability in 11 preterm infants with IUGR and in 11 preterm infants with normal intrauterine growth. IUGR preterm infants had a smaller hippocampal volume when compared to preterm infants without IUGR.
14:00 585. **The Neural Basis of Declining IQ in Preterm Children**
Elizabeth B. Isaacs1, Caroline J. Edmonds1, Wui K. Chong1, Alan Lucas1, David G. Gadian1
1University College London, London, UK; 2Great Ormond Street Hospital for Children NHS Trust, London, UK

This study examined IQ scores obtained in childhood and again in adolescence from children born at 30 weeks gestation or less who had normal neurological examinations. Verbal IQ (VIQ) and Performance IQ (PIQ) mean scores decreased significantly between the two time points. Bilateral voxel-base morphometry analyses of 3D MPRAGE datasets acquired at adolescence showed a positive correlation between VIQ decline and white matter in the frontal lobes, a positive correlation between PIQ decline and cerebellar grey matter density, and a negative correlation between PIQ decline and grey matter density in the hippocampal region.

14:10 586. **Characterization of Cerebral Cortical Folding in the Developing Infant Brain**
Haissam Haidar1, Adre Jacques du Plessis1, Janet Susan Soul2
1Children's Hospital, Boston, Massachusetts, USA

Quantification of cortical folding in the developing human brain would be critical to elucidate the factors governing the complex development of the cerebral gyral-sulcal pattern. We measured mean curvature of the cortical surface and used a new measure (folding index, FI) to quantify the cortical folding using 3D MRI data obtained in 15 infants born prematurely at 3 different time points. We found a statistically significant increase in both mean curvature and FI from preterm to one year of age, demonstrating the utility of these methods in characterizing the developing cerebral cortex in infants.

14:20 587. **Diffusion-Weighted MRI Analysis of the Effects of Prematurity and White Matter Injury on Cerebral Cortical Development**
Tammie L.S. Benzinger1, Terrie E. Inder1, Amit Mathur1, Alpay Ozcan1, Abraham Z. Snyder1, Hong Xin Wang1, Michael Keana1, Jeffrey J. Neil1
1Washington University, St. Louis, Missouri, USA; 2Royal Children's and Royal Women's Hospitals, Melbourne, Victoria, Australia; 3University of Melbourne, Melbourne, Victoria, Australia

This study uses diffusion MRI techniques to demonstrate cortical gray matter abnormalities in prematurely-born human infants imaged at term. Quantitative measures of the apparent diffusion coefficient (ADC) and relative anisotropy (RA) were calculated for regions of interest in the frontal and parieto-occipital (PO) cortex. Significantly lower ADC values are found in PO cortex for prematurely-born infants when compared to control term infants. For both frontal and PO cortex, RA is significantly lower in those preterm infants with white matter injury, suggesting an association between white matter injury and alterations in gray matter maturation.

14:30 588. **Frontal White Matter and Cognitive Development in Adolescence**
Monica Luciana1, Catalina Hooper2, Heather Conklin1, Kelvin O. Lim1
1University of Minnesota, Minneapolis, Minnesota, USA

During adolescence, there are distinct developmental trajectories for different types of cognitive tasks. We used DTI as a tool to measure white matter maturation and examined the association of task performance and white matter maturation between the ages of 10 and 16 years. Significant associations were found between cognitive performance and mean diffusion in several frontal white matter regions.

14:40 589. **Regional Correlation of Fractional Anisotropy in Brain with Reading Ability in Children**
Christian Beaulieu1, Chris Plewes1, Lori Ann Paulson1, Dawne Roy1, Lindsay Snook1, Simon Mccrea1, Linda Phillips1
1University of Alberta, Edmonton, Alberta, Canada

Imaging studies, primarily fMRI, have provided evidence that dyslexia has a neurobiological origin. Regional white matter connectivity has been shown to correlate with reading ability in adults. Diffusion tensor imaging (DTI) of the brain was performed in healthy 8-12 year old children (N=52) with a range of reading ability. A whole-brain, voxel-based morphometric linear regression analysis yielded clusters with significant correlation between reading ability (Word ID) and fractional anisotropy in focal white matter tracts of the left hemisphere. Quantitative DTI provides evidence of an association between reading performance and brain connectivity at a young age when these skills are developing.

14:50 590. **Activation of the Sensory-Motor Pathways in the Premature Brain: A Combined fMRI and DTI Study**
Stephan G. Erberich1, Ashok Panigrahy1, Linda Tesoriero1, Jon Nielsen1, Philippe Friedlich1, Istvan Seri1, Marvin D. Nelson1, Floyd Gilles1, Stefan Bluml1
1CHLA/USC, Los Angeles, California, USA

fMRI in pre-term and term newborns is a promising, but challenging, method. We hypothesis, that fMRI in newborns can reveal functional activation in the premature brain, yet the outcome might differ substantially from those of older children. A novel MR incubator (MRCI) was utilized to successfully study fMRI/DTI of the sensory-motor pathways in 24 newborns (GA25-41-weeks, mean=37-weeks). Results: (i) activation occurs as a string along the sensory-pathways, (ii) deactivation is a dominant feature of the newborn, (iii) post- and precentral gyri are lateralized to a grater extent (13%) compared to the overall hemispheres (2%) at this age.
15:00  591. Visual System Recovery After Perinatal Stroke Evidenced by DTI and Event-Related fMRI
Mohamed L. Seghier1, François Lazeyras2, Slava Zimine2, Stephan E. Maier2,
Sonja Saudan-Free1, Petra S. Huppi1
1University Hospital of Geneva, Geneva, Switzerland; 2Children's Hospital, Harvard Medical School, Boston, Massachusetts, USA;
3Children's Hospital of Geneva, Geneva, Switzerland

The aim of this study is to assess recovery of the visual network after perinatal stroke in an infant with DTI and event-related fMRI. Visual stimuli have resulted in negative BOLD signal in the anterior calcuare sulcus of the intact right hemisphere. Surprisingly, at 20 month of age, significant activation was also detected in the visual cortex of the injured left side that was not observed previously at 3 month of age. DTI vector map suggests recovery of parts of the left optic radiation in the vicinity of the lesion and the presence of fibers from the posterior forceps.

15:10  592. Early Laminar Organization of the Human Cerebrum Demonstrated by Automatic Segmentation of Diffusion Tensor MR Images in Extremely Premature Infants
Julio Carballido-Gamio1, Pratik Mukherjee1, Luis C. Maas1, Sri Veeraraghavan1, Steven P. Miller1, Savannah C. Partridge1, Roland G. Honry1, A. James Barkovich1, Daniel B. Vigneron1
1University of California, San Francisco, San Francisco, California, USA

A Mamdani-type fuzzy inference system was applied to diffusion tensor MR images to automatically segment the transient early cerebral lamina present in the developing brain of extremely premature newborns. This fuzzy logic algorithm takes the apparent diffusion coefficient and fractional anisotropy pixel values and segments the images into three different cerebral lamina: a cortical layer, a subplate layer, and a deep-to-subplate layer that includes the intermediate zone, subventricular zone, periventricular zone, and germinal matrix. Results of this automated segmentation were comparable to those obtained with manual image segmentation in two premature infants of 25 and 27 weeks gestational age.

15:20  593. Diffusion Tensor Imaging Assessment of the White Matter in Preterm Infants who Show Diffuse White Matter Changes on Conventional Magnetic Resonance Imaging at Term Equivalent Age
Serena J. Counsell1, James P. Boardman1, Yuji Shen1, Olga Kapellou1, David J. Larkman1, Joanna M. Allsop1, Joseph V. Hajnal1, David Edwards1, Mary A. Rutherford1
1Hammersmith Hospital, Imperial College London, London, UK

Diffusion tensor imaging (DTI) was performed on 33 preterm infants (7 with normal appearing white matter and 26 with diffuse excessive high signal intensity [DEHSI]) and 6 term born control infants. ADC values were elevated and RA was reduced in preterm infants with DEHSI compared to both term born controls (ADC, p<0.001; RA, p=0.063) and preterm infants with normal appearing white matter (ADC, p=0.003, RA, p=0.02). The reduction in RA and elevation in ADC in preterm infants with DEHSI suggests microstructural abnormalities within the white matter in this group of preterm infants.

CLINICAL SCIENCE FOCUS SESSION
fMRI: Drugs, Pain, and Treatment

Micheal D. Phillips1, Kenneth B. Baker2, Mark J. Lowe1, Jean A. Tkach1, Scott Cooper1, Brian Kopell1, Ali R. Rezai1
1Cleveland Clinic Foundation, Cleveland, Ohio, USA

Four patients with percutaneously-extended bilateral DBS electrodes in the STN for the treatment of PD were studied using BOLD fMRI on a 3T MRI on the first or second postoperative day. All four of the patients were able to complete the study. Good activation was demonstrated from 6 of the 7 electrodes stimulated. In all cases activation was demonstrated in the anterior thalamus and posterior portions of the globus pallidus and putamen. Stimulation of therapeutically effective contacts of a DBS electrode in the STN produces a consistent pattern of ipsilateral activation deep brain motor structures.

13:40  595. Human Hypothalamic Responses Following Glucose Ingestion
Paul A.M. Smeets1, Matthias J.P. van Osch2, Annette Stafleu1, Cees de Graaf2, Jeroen van der Grond1
1University Medical Center Utrecht, Utrecht, Netherlands; 2TNO Nutrition and Food Research, Zeist, Netherlands

The hypothalamus is intimately involved in the regulation of food intake. In this study, we investigated BOLD signal changes in the human hypothalamus after administration of two different doses of glucose. This is the first study showing a prolonged and dose-dependent decrease of fMRI signal in part of the hypothalamus after glucose ingestion. The time course and dose-dependency of this hypothalamic response suggest that it is associated with changes in blood glucose and insulin levels.
13:50 596. Flow and Metabolism Remain Coupled in Acute Insulin Induced Hypoglycemia in Human Brain
Richard P. Kennan1, Cathy Nadal1, Cynthia Pan1, Harry Shamo1, Jullie Pan1
1AECOM, Bronx, New York, USA

How the brain functions under conditions of acute hypoglycemia remains a complex question, by virtue of the potential simultaneous shifts in processes of perfusion, metabolism and changing demand. In the present study we examined this issue by measuring cerebral blood flow and oxidative metabolism in insulin induced hypoglycemic (HG) and euglycemic (EG) conditions at rest and during sensorimotor activation in normal human subjects. Data in EG and HG conditions show that although there is variability in the blood flow response, that CMRO2 remains coupled to CBF with minimal changes to the sensorimotor-activation induced blood flow response.

14:00 597. Evaluation of Language and Hand Motor Function with fMRI in Patients with a Brain Mass Lesion: Validation with Intraoperative Electrocortical Mapping
Alberto Rizzi1, Valeria Blasi1, Marcello Cadioli2, Ugo Danesi1, Carlo Marras1, Paolo Ferrotti1, Dario Caldirol1, Gianni Broggi1, Andrea Falini1
1Neurologo Carlo Besta, Milan, Italy; 2Università Vita-Salute San Raffaele, Milan, Italy

Aim of the study was to evaluate sensitivity and specificity of preoperative fMRI in identifying eloquent areas for language and hand motor function. Twenty patients with a cerebral mass lesion were studied. fMRI data were registered in a frameless stereotactic neuronavigational device to allow comparison with intraoperative direct electrocortical stimulation (ECS). Ninetyfour cortical sites were tested for language with ECS in 12 patients and 41 sites for motor functions in 8 patients. Comparison of data from the two techniques demonstrated that fMRI sensitivity was 82% and specificity was 61% for language, and 87% and 76% respectively for motor function.

14:10 598. Reproducibility of fMRI for the Definition of Functional Margins in Radiotherapy Planning
Roberto Garcia-Alvarez1, Gary P. Liney1, A. Beavis1, Lindsay W. Turnbull1
1University of Hull, Hull, UK; 2Princes Royal Hospital, Hull, UK

This study examines the inter and intra-subject variability of fMRI in terms of its application for Radiotherapy planning. A bilateral motor paradigm was used in a cohort of normal volunteers in order to establish the degree of reproducibility in the dominant and non-dominant hand. Results demonstrate that the BOLD technique is much more consistent for the primary motor cortex representing the dominant hand. These results will help to establish the margins of error used at the Radiotherapy planning stage

14:20 599. Cortical Centres Mapping by fMRI in Patients with Brain Tumors
Agata Majos1, Piotr Grzelak1, Krzysztof Tybor1, Bozena Goraj1, Ludomir Stefanczyk1
1Medical University of Lodz, Lodz, Poland

The aim - Establishing the effectiveness of fMRI with ICS and SSEP in planning the cortex centers-saving neurosurgical interventions. 33 patients with brain tumors located in the central sulcus vicinity were included. They underwent fMRI when two paradigms activated motor and sensory cortex were performed and awakened surgery. Topographical relations of activated areas near the tumor were compared between fMRI and intraoperative techniques. There was a high agreement between them. 1. The spatial correlation between fMRI and intraoperative methods for sensorimotor cortex is very high 2. fMRI as a preoperative method is very helpful for planning neurosurgical interventions

14:30 600. Decreased BOLD Activation during Visual Attention Tasks in Marijuana Abusers
Linda Chiang1, Katarina Leckova1, Christine Cloak1, Sheeba Arnold1, Renat Yakupov1, Carl Lozar1, Kelly Warren1, Thomas Ernst1
1Brookhaven National Laboratory, Upton, New York, USA

Marijuana users commonly have memory deficits and attention problems. fMRI was performed in 13 marijuana users and 18 controls during a set of visual attention tasks. Despite similar performance, marijuana users showed decreased activation in the cerebellar vermis and dorsal parietal region during visual attention tasks. Marijuana users also showed dose-dependent decreases in BOLD signal in the cerebellar vermis. Decreased BOLD activation in these brain regions may be due to marijuana-induced alteration in resting cerebral blood volume / flow or neurochemistry. Future perfusion and receptor binding studies are needed to evaluate the relationship between these variables and BOLD signals.

14:40 601. Somatotopic Organization of Acupoints in Human Primary Somatosensory Cortex - A fMRI Study
Asuka Nakagoshi1, Masaki Fukunaga1, Ichio Aoki1, Masahiro Umeda1, Yuki Mori1, Yoshiaki Someya1, Chuzo Tanaka1
1Meiji University of Oriental Medicine, Kyoto, Japan; 2National Institutes of Health, Bethesda, Maryland, USA; 3BF Research Institute, Osaka, Japan

The purpose of this study was to investigate somatotopic organization of acupoints in human primary somatosensory cortex. Eleven healthy volunteer were examined on 1.5T MRI to acquire fMRI. The scanning was conducted in the same acupoints with block design. All data were analyzed on SPM99. We could detect significantly activation at contralateral somatosensory area during stimulation on all acupoints. These results were similar as somatotopic representation in S1 reported by Penfield et al. We also found significant activation in S2 at all acupoints. This study reveals somatotopic mapping of acupoints and gives basis for understanding the mechanisms of acupuncture treatment.
14:50  602.  **Modification of Brain Activation of Neuropathic Pain During Lidocaine Infusion: An fMRI Study**  

*Annie Papadaki¹, Bob Homapour², Donald McRobbie¹, Rebecca Quest¹, Derek Duane¹, Praveen Anand¹*  
¹Imperial College, London, UK  

Functional MRI was used to assess the effect of lidocaine infusion in patients suffering with neuropathic pain. It has been suggested that neuropathic pain may be caused by abnormal activity in the form of ectopic discharges via the activation of sodium channels. Lidocaine, a sodium channel blocker, may attenuate neuropathic pain and skin hypersensitivity in some patients. Six patients that have developed hypersensitivity in the form of allodynia were scanned on a 1.5T MRI system during saline and lidocaine infusion while a tactile stimulation was performed. Five out of six patients showed significant BOLD signal decrease during lidocaine infusion.

15:00  603.  **Dissociating the Anaesthetic and Analgesic Properties of Ketamine Using fMRI**  

*Richard Rogers¹, Richard G. Wise¹, Debbie J. Painter¹, Sarah E. Longe¹, Irene Tracey¹*  
¹Oxford University, Oxford, UK  

We use FMRI to demonstrate that brain activity induced by noxious thermal stimulation in volunteers is reduced by acute administration of ketamine. This was consistent with the observed subjective analgesia. The most significant reductions were observed in the insular cortex and thalamus. An auditory and a motor task were also applied to distinguish the analgesic effects of ketamine from its effects on other cortical processes. In comparison to pain-related activity, auditory and motor cortical activity were influenced differently by the three ketamine plasma concentrations used.

15:10  604.  **Role of Functional Brain Changes in Primary Progressive Multiple Sclerosis**  

*Olga Ciccarelli¹, Ahmed T. Toosy¹, Jonathan F. Marsden¹, Claudia M. Wheeler-Kingshott¹, Gordon T. Ingle¹, David H. Miller¹, Alan T. Thompson¹*  
¹Institute of Neurology, UCL, London, UK  

Our aim was to investigate the role of functional changes in 13 patients with primary progressive MS by employing active and passive movement of the foot. A custom made wooden manipulandum was used. Patients activated more than controls during active movement of either foot in the contralateral cerebellum and precuneus, whilst during passive movement they activated more in the ipsilateral striatum. Disability and brain damage had both positive and negative effects on the observed functional changes, whilst spinal cord atrophy had a positive effect, suggesting that the role of these changes might be adaptive or non-adaptive depending on region.

15:20  605.  **Evidence for Functional Reorganization as a General Response to Motor System Injury in Multiple Sclerosis Patients**  

*Stephanie C. Manson¹, J Palace¹, Mark Jenkinson¹, Paul M. Matthews¹*  
¹Oxford University, Oxford, Oxfordshire, UK  

Brain functional reorganization could contribute to reducing the clinical disability of patients with multiple sclerosis (MS). To test this, we compared the localization of activity for simple hand and tongue movement tasks between healthy controls and MS patients. We found significant shifts in centre of activity throughout the motor cortex, consistent with reorganization of functional activity.

**CLINICAL SCIENCE FOCUS SESSION**  
Cancer Diagnosis and Brachytherapy

Room B-2  13:30 - 15:30  
Chairs: Leo L. Cheng and John Kurhanewicz

13:30  606.  **Transperineal MRI-Guided High-Dose-Rate (HDR) Prostate Brachytherapy and Biopsy in a Standard 1.5T Scanner: Clinical Experience**  

*Cynthia Menard¹, Robert C. Susil², Peter Choyke¹, Elliot McVeigh¹, Holly Ning¹, Robert W. Miller¹, Karen L. Ullman¹, Victor Wright¹, Peter Guion¹, C. Norman Coleman¹, Kevin Camphausen¹*  
¹National Institutes of Health, Bethesda, Maryland, USA; ²Johns Hopkins University, Baltimore, Maryland, USA  

MRI provides superior visualization of the prostate and surrounding anatomy making it the modality of choice for imaging prostate cancer. We present clinical results of a novel technique for transperineal needle placements applied to biopsy and HDR prostate brachytherapy in a standard 1.5T MRI scanner. Our results show that this technique is feasible, safe, and achieves accurate needle placements and favorable dosimetry with high-quality image guidance. This approach may offer a therapeutic advantage as visible tumor-bearing regions of disease may be preferentially targeted for higher radiation dose delivery.
13:40  607. A Novel MRI Compatible Manipulator for Prostate Interventions

Axel Krieger1, Robert C. Susi1, Cynthia Ménard2, Jonathan A. Coleman1, Gabor Fichtinger1, Louis L. Whitcomb1, Ergin Atalar1
1Johns Hopkins University, Baltimore, Maryland, USA; 2National Institutes of Health, Bethesda, Maryland, USA

This paper reports a novel remotely actuated manipulator for trans-rectal prostate imaging and intervention, designed for use in a conventional, closed configuration, 1.5T MRI scanner. The device provides three-dimensional MRI guided needle placement with millimeter accuracy under physician control. Candidate procedures enabled by this device include MRI guided needle biopsy, fiducial marker placements, and therapy delivery. Its compact size allows for use in both closed and open configuration MRI scanners. Placement accuracy results in first clinical trials are reported.

13:50  608. Diffusion-Weighted MRI in the Discrimination between Intracerebral Necrotic Tumors and Cerebral Abscesses.

Lisbeth Roht1, Jens Christian Sorensen1, Anette Obe1, Lili Elggaard1, Lise Bro1, Edith Nielsen1, Anne Marie Nehan1
1Aarhus University Hospitals, Århus, Denmark

A cerebral abscess can be a lethal condition if correct treatment is not initiated acutely. Unlike conventional MRI, diffusion-weighted MRI can be used to discriminate between cerebral abscesses and necrotic brain tumors, but the sensitivity and specificity is uncertain. We studied 15 patients with necrotic tumors and 4 patients with abscess. Only one patient with tumor was misdiagnosed, yielding a sensitivity and specificity of 93% and 100%, respectively. Furthermore, an absolute ADC value of 1.0 x 10-3mm2/sec in the cavity can probably be used to discriminate necrotic brain tumors from the cerebral abscesses.

14:00  609. Automated Classification of 1H MRS Brain Tumour Spectra: A Linear Discriminant Analysis

Kirstie S. Opstad1, Christophe Ladroue3, John R. Griffiths1, Franklyn A. Howe1
1St. George's Hospital Medical School, London, UK

Current pattern recognition studies on 1H MRS brain tumor spectra have been unsuccessful distinguishing glioblastoma from metastasis. This study investigates leave-one-out linear discriminant analysis on LCModel quantified concentrations versus complete spectra (TE 30ms); effects of combining PRESS and STEAM data versus STEAM data alone; and effects of using principal component analysis against manually choosing metabolite concentrations from the LCModel quantification. We conclude that using LCModel concentrations provides a similar degree of separation when compared with pattern recognition on 1H brain tumor spectra but unlike spectral pattern recognition, concentrations determined from STEAM spectra provides good separation (87%) of glioblastoma from metastasis.

14:10  610. 1H NMR Spectroscopic Study of Lipid T1 and T2-Relaxation in BT4C Rat Gliomas In Vivo

Timo J. Liimatainen1, Seppo Ylä-Herttuala1, Juhana M. Hakumäki1
1University of Kuopio, Kuopio, Finland

In this study, we investigated tumor lipid T1- and T2-relaxation by 1H NMR spectroscopy to facilitate lipid quantification in vivo and to gain more insight on the triglyceride microenvironment in lipid bodies during ganciclovir-induced apoptotic cell death. The T1- and T2-relaxation times of 0.9 ppm and 1.3 ppm resonances were found to shorten significantly during treatment. With increasing droplet size, this can imply increased lipid body-associated protein concentration. The results show that relaxation studies may be used to address the in vivo dynamics of lipid bodies in biological systems.

14:20  611. Combined Proton MRSI Tumor Biomarkers Improve Accuracy in Differentiating Clinical Grade of Pediatric Brain Tumors

Loukas G. Astrakas1, Maria K. Zarifi1, Tina Young Poussaint2, David Zurakowski2, Liliana Goumnerova2, Douglas Anthony2, Peter McL Black2, A Aria Tzika1
1Massachusetts General Hospital and Shriners Institute, Harvard Medical School, Boston, Massachusetts, USA; 2Children's Hospital Boston, Harvard Medical School, Boston, Massachusetts, USA

We evaluated proton MRSI exams on 76 children with brain tumors. Important biomarkers, choline-containing compounds (Cho), N-acetylaspartate (NAA), total creatine (tCr), lipids and/or lactate (L) were measured. Area under the ROC curve for the multivariate predictors of tumor grade (Cho and L) was 0.854 (p<0.001). Regression modeling indicated that when both predictors were above their cutoff values (Cho/tCr >= 1.0 and L/tCr >= 2.0) the probability of high-grade tumor increased to 84%. Combining proton MRSI biomarkers for distinguishing low-grade from high-grade tumor is an excellent test in children, especially if diagnostic biopsy is unfeasible.

14:30  612. 3D 1H-MR Spectroscopic Imaging of the In Vivo Human Prostate with Combined External Coils

Tom Scheenen1, Stefan Roell2, Sijin Heijmink1, Arend Heerschap1
1University Medical Center Nijmegen, Nijmegen, Netherlands; 2Siemens Medical Solutions, Erlangen, Germany

3D 1H-MRSI of the human prostate was performed without an endorectal coil with a useful spatial resolution. Spectroscopic signals from multiple exter-nal (standard) coils around the male pelvis were combined using the amplitude and phase of the data point at the echo top of a PRESS pulse sequence for every individual pixel and every individual coil. The weighted combination of signals from the different coils produced uncontaminated spectra throughout the whole prostate with a resolution of 1.7 cm3 within 11 minutes.
Whole-Body MRI and Whole-Body Dual-Modality PET/CT for Tumor Staging in Oncology
Florian M. Vogt, Gerald Antoch, Sandra Massing, Patrick Veit, Lutz S. Freudenberg, Andreas Bockisch, Jörg Barkhausen, Jörg F. Debatin, Stefan G. Rühm
1University Hospital, Essen, Germany

The purpose of this study was to compare the diagnostic value of whole-body MRI with whole-body PET/CT for tumor staging. 50 patients with different malignant diseases were prospectively evaluated. Two blinded radiologists each read the images and results were compared with either histology or radiological follow-up. MRI was able to determine bone metastases more accurately, whereas PET/CT proved superior for the detection of lymph node metastases and pulmonary metastases. The study indicates that whole-body PET/CT and whole-body MRI complements one another in the staging of malignant diseases.

Quantitative 1H MRS and Diffusion MRI of Untreated Pediatric Primitive Neuroectodermal Tumors
Nilesh R. Ghugre, Ashok Panigrahy, Arzu Kovanlikaya, Ignacio Gonzalez, Mark Krieger, Marvin D. Nelson, Stefan Bluml
1Childrens Hospital Los Angeles, Los Angeles, California, USA

We performed quantitative 1H MRS and diffusion weighted MRI (DWI) in patients with primitive neuroectodermal tumors (PNET), other tumors, and controls. High taurine levels were observed in all PNET patients, well separating them from the rest of the cases. Apparent diffusion coefficients (ADCs) in PNET were not significantly different from periventricular white matter ADC. A large variation in taurine concentration and ADC was observed within the PNET subgroup indicating heterogeneity of individual cases. A weak negative correlation was seen between ADC and taurine. 1H MRS and DWI may be used to provide additional parameters to characterize malignancy of PNET preoperatively.

Characterization of Prostate Cancer by Quantitative MRI
David L. Buckley, Caleb Roberts, Sajida K. Khaki, Geoff JM Parker, John P. Logue, Charles E. Hutchinson
1University of Manchester, Manchester, UK; 2Christie Hospital, Manchester, UK

The purpose of this study was to assess baseline physiology and MR characteristics of the pathological prostate gland prior to radiotherapy. Twenty-two patients were studied using T1 and T2 mapping, dynamic contrast-enhanced MRI and a distributed parameter tracer kinetic model. As previously reported, T2 in tumours was low compared to normal peripheral zone with no difference in T1. In addition, blood flow and interstitial volume were significantly increased whereas no differences were observed in blood volume or microvessel PS-product. Quantitative measures such as these may serve as sensitive indicators of tissue response to treatment.

Role of In-Vivo Proton Magnetic Resonance Spectroscopy (PMRS) and Diffusion Weighted Imaging (DWI) in the Differential Diagnosis of Intracranial Cystic Mass Lesions
Deepak Jha, Asht Mangal Mishra, Ramandeep Singh Jaggi, Sanjeev Chawla, M Agarwal, Nazhat Husain, Mazhar Husain, KN Prasad, Rakesh Kumar Gupta
1King George Medical University, Lucknow, Uttar Pradesh, India; 2SGPGIMS, Lucknow, Uttar Pradesh, India

We studied fifty-five patients of cystic intracranial lesions, which include abscesses (n=25), benign cysts (n=5) and tumor cysts (n=25) by diffusion weighted imaging (DWI) and proton MR spectroscopy (PMRS). Results were conclusive in 18/25 cases of abscesses on DWI whereas PMRS was conclusive in all but one. When both techniques were combined, the results were conclusive in all the patients with abscesses. DWI was conclusive in 19 tumor cysts and 5 benign cysts whereas PMRS was conclusive in remaining 6 cases of tumor cysts. When PMRS is combined with DWI, it helps in better differentiation of cystic brain lesions.

Quantitative MR Imaging of the Biodistribution of Holmium-Loaded Microspheres used for Internal Radiation Therapy of Liver Tumors
Jan-Henry Seppenwoolde, Frank Nijsen, Lambertus W. Bartels, Sander W. Zielhuis, Fred van het Schip, Chris J. G. Bakker
1University Medical Center Utrecht, Utrecht, Netherlands

In this study, we assessed the quantitative MR imaging of the biodistribution of holmium-loaded microspheres (HoMS) that are used in internal radiation therapy of liver tumors. A validation study was performed in ex vivo rabbit livers and in vivo animal models. It was shown that the calculated amount of HoMS was proportional to the actually injected amount, but generally underestimated it. The underestimation was less if a small dose was used, if the biodistribution was more homogeneous, or if a larger animal model, i.e. a pig, was used. The described exploratory quantification experiments suggest the feasibility of MR dosimetry.
Diffusion: Fibers, Layers, and Areas

Main Hall  16:00 - 18:00  Chairs: Timothy Behrens and Carlo Pierpaoli

16:00  618.  Artifact or Architecture? An Integrated Approach to Visualizing Uncertainty and Partial Volume Effects in DT-MRI Tractography
Derek K. Jones¹, Adam R. Travis¹, Gregory M. Eden¹, Carlo Pierpaoli¹, Peter J. Basser¹
¹National Institutes of Health, Bethesda, Maryland, USA; ²Vanderbilt University, Nashville, Tennessee, USA; ³Montgomery Blair High School, Silver Spring, Maryland, USA

In DT-MRI tractography, while the trajectories of fasciculi have been visualized, other tract-specific measures (including uncertainty in fiber orientation and partial volume artifacts) have not. Here we describe an integrated approach, based on the bootstrap method and hyper-streamline visualization, which enables these measures to be visualized together with the trajectories of white matter fasciculi in a concise and readily interpretable manner. This approach provides a deeper understanding of potential artifacts in tractography than ‘trajectory-only’ visualizations allow and can help one decide whether a tractography result is artifact or architecture.

16:12  619.  Automatic Segmentation of White Matter Pathways by Application of a Region Growing Algorithm
Thomas Richard Barrick¹, Ian Nigel Lawes¹, Christopher Alan Clark¹
¹St George's Hospital Medical School, London, UK

Current fibre tracking techniques involve determination of regions of interest (ROIs) through which tracks must pass to be retained. White matter pathway generation is therefore limited by inter and intra-rater variability in ROI placement. Here we present the first fully automatic technique for segmentation of white matter pathways from diffusion tensor images throughout the entire brain. The technique removes the need for ROI definition and automatically segments pathways from automatically generated single seed points by application of a novel region growing algorithm (RGA) that analyses track start and end points, track length and mean track orientation parameters.

16:24  620.  NURBS in DT-MRI
Sinisa Pajevic¹, Peter J. Basser¹
¹National Institutes of Health, Bethesda, Maryland, USA

Several approaches provide a continuous tensor field approximation to discrete, noisy tensor data, which have been applied to fiber tractography. The problem with these continuous models is that they fail to provide reliable estimates of useful quantities that arise in differential geometry, like curvature and torsion, which describe useful geometric features of a tract. We propose that Non-Uniform Rational B-Splines (NURBS) are a suitable tool to achieve this end.

16:36  621.  Delineation of Functional Subunits in the Human Cortex from Diffusion Based Connectivity Matrices
Timothy EJ Behrens¹, Heidi Johansen-Berg¹, Ivana Drobnjak¹, J Michael Brady¹, Paul M. Matthews¹, Stephen M. Smith¹, Desmond J. Higham²
¹University of Oxford, Oxford, UK; ²University of Strathclyde, Glasgow, Strathclyde County, UK

We explore the use of diffusion tractography to define functionally relevant anatomical subunits in the human visual system. Probabilistic diffusion tractography is used to generate a connectivity matrix of the visual system. This matrix is submitted to a spectral reordering routine such that nearby nodes in the reordered matrix are strongly related in the data. The reordered matrix exhibits a hierarchical form in which clusters of nodes emerge. When mapped back into anatomical space, these clusters appear to correspond well with the ventral and dorsal processing streams in the visual system and primary visual cortex.

Van J. Wedeen¹, S. K. V. Song², Larry Wald¹, Timothy Gordon Reese³, Thomas Benner¹, W. Y. I. Tseng³
¹Massachusetts General Hospital and the Harvard Medical School, Boston, Massachusetts, USA; ²Washington University, St. Louis, Missouri, USA; ³National Taiwan University, Taipei, Taiwan

This study investigates the capacity of diffusion spectrum MRI (DSI) to delineate the cytoarchitectonics of the cerebral cortex, DSI, by reconstructing full 3D probability density function (pdf) of diffusion at each voxel, affords a capacity to delineate complex neural architecture. Imaging mouse brain ex-vivo, this study presents methods for the creation and analysis of cortical contrast, emphasizing the planar or 2D structure of the diffusion pdf. To test this, we first use it to construct 3D graphics which reveal known features of cortical laminar architecture and second, use these data as the basis for an automated cortical segmentation.
17:00 623. **Diffusion Spectrum Imaging Tractography in Complex Cerebral White Matter: An Investigation of the Centrum Semiovale**

Patric Hagmann¹, Timothy G. Reese², Wen-Yih Isaac Tseng³, Reto Meuli⁴, Jean-Philippe Thiran¹, Van Jay Wedeen²

¹Swiss Federal Institute of Technology, Lausanne, Switzerland; ²Harvard Medical School, Charlestown, Massachusetts, USA; ³National Taiwan University College of Medicine, Taipei, Taiwan; ⁴University Hospital, Lausanne, Switzerland

DSI is a novel high angular resolution diffusion MR imaging technique with high b-values that is able to map complex white matter architecture in the brain. We evaluate the capacity of a simple tractography method to define the essential fiber crossing anatomy. We find a cortico-spinal tract that spreads along the motor strip, callosal fibers that widely distribute throughout the parietal cortex and the arcuate fasciculus. All three fiber types intermix in a complex manner in the centrum semi-ovale.

17:12 624. **Identification of an Amygdalo-Fusiform Pathway in Humans using Diffusion Tensor Tracking**

Charles D. Smith¹, Nicolas Lori², Erbil Akbudak², Ertugrul Sorar², Joshua S. Shimony², Thomas Edward Conturo²

¹University of Kentucky Medical Center, Lexington, Kentucky, USA; ²Washington University School of Medicine, St. Louis, Missouri, USA

Using MRI diffusion tensor tracking (DTT), we demonstrate a consistent bilateral white matter fiber pathway between human cortical area 37 (fusiform area) and the ipsilateral amygdala. Such a pathway may have significant implications in understanding the connectional anatomy and function of the human brain in normal and pathologic states, and particularly in Alzheimer's disease.

17:24 625. **DTI Tractography of the Wernicke and Broca Connectivity in Right and Left Hander**

Patric Hagmann¹, Leila Cammoun¹, Roberto Martuzzi², Philippe Maeder¹, Stéphanie Clarke², Jean-Philippe Thiran¹, Reto Meuli²

¹Swiss Federal Institute of Technology, Lausanne, Switzerland; ²University Hospital, Lausanne, Switzerland

We use DT-MRI and statistical fibre tracking in order to quantify the left-right asymmetry of connectivity between the posterior part of the superior temporal gyrus (Wernicke) and the homolateral pars opercularis of the frontal inferior gyrus (Broca) in 12 healthy subjects. Our results show that there is a left-right brain asymmetry in terms of connectivity. A right handed population has denser association pathways left which seems to be fairly constant over that population (small variance). The left handed population seems to be more heterogeneous in terms of lateralisation though if lateralized it will be frequently on the right.

17:36 626. **Functional-Anatomical Validation of Diffusion Tractography-Based Segmentation of the Human Thalamus**

Heidi Johansen-Berg¹, Timothy EJ Behrens¹, Emma Sillery¹, Olga Ciccarelli¹, Alan J. Thompson¹, Stephen M. Smith¹, Paul M. Matthews¹

¹University of Oxford, Oxford, UK; ²University College London, London, UK

Parcellation of the human thalamus based on cortical connectivity information inferred from non-invasive diffusion-weighted images (DWI) identifies sub-regions that we propose correspond to thalamic nuclei. Here we test the functional and anatomical validity of this proposal by comparing data from tractography, cytoarchitectural and functional imaging. The relative volumes of connectivity-defined sub-regions correlate with volumes based on a histological atlas. Previously reported functional thalamic activations during motor or executive tasks co-localise within regions showing high probabilities of connection to motor or prefrontal cortices, respectively. This work provides a powerful validation of quantitative grey matter segmentation using diffusion tractography in humans.

17:48 627. **Interactive Three-Dimensional Digital Atlas of the Fiber-Tract in Human Brain**

Hangyi Jiang¹, Setsu Wakana¹, Lidia M. Nagae-Poetscher¹, Peter C.M. van Zijl¹, Susumu Mori¹

¹Johns Hopkins University, School of Medicine, Baltimore, Maryland, USA

An electronic atlas of the white matter tracts in human brain has been developed based on in vivo diffusion tensor imaging (DTI) and DTI-based tractography. The trajectories of prominent white matter tracts are reconstructed, superimposed on different MR images and visualized in 2D orthogonal and 3D triplanar views. Various anatomical units are manually defined to visualize the relationship with tracts. The atlas supports oblique viewing, zooming, and rotation, capabilities that are not available in print atlases. Fusion of information from various white matter tracts and gray matter structures assists the users in comprehensively understanding white matter anatomy and functionality.

**MR PHYSICS AND TECHNIQUES FOR CLINICIANS**

Room A 16:00 – 18:00 Chairs: Frank R. Korosec and Joseph C. McGowan

Educational Objectives

Upon completion of this course, participants should be able to:
Define and describe the fundamental principles of MR imaging, including the definition of spin magnetization, the Larmor relationship, relaxation phenomena, and the process of using the spin magnetization to produce an image;

- Explain imaging pulse sequences based upon spin and gradient echoes, including fast spin echo and echo planar techniques;

- Design MR imaging protocols for diagnostic applications considering image contrast, spatial resolution, acquisition time, signal-to-noise ratio, and artifacts;

- Describe the principles and capabilities of various advanced MR techniques, including diffusion, cardiac and functional MRI and spectroscopy.

16:00  **Vascular Imaging**  
*Matt A. Bernstein*

16:40  **Cardiac Imaging**  
*Debiao Li*

17:20  **fMRI**  
*Peter Jezzard*

18:00  **Adjournment**

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### Annex 1  16:00 - 18:00  
**Chairs: Walter F. Block and Tabias Schaeffter**

**16:00**  **628. Slice Excitation for Ultrashort TE Imaging**  
*Christoph Schroeder*, *Peter Boernert*, *Juergen Rahmer*  
1Philips Research Laboratories, Hamburg, Germany

Self-refocused half-sinc RF excitation pulses for imaging at ultrashort echo times (< 100 us) have been studied. To excite a slice, two subsequent half-sinc RF pulses are applied, which are self-refocused and limit the echo time to only the hardware switching time. For the excited slice, the quality of the slice-selection gradient is critical. In this paper, different schemes to compensate for the non-ideal gradients are investigated.

**16:12**  **629. Ultra-Short TE Imaging with Single-Digit (8µs) TE**  
1GE Medical Systems, Menlo Park, California, USA; 2GE Medical Systems, Milwaukee, Wisconsin, USA; 3Stanford University, Stanford, California, USA; 4University of California at San Diego, San Diego, California, USA; 5University of Southern California, Los Angeles, California, USA

Ultra-short TE (UTE) imaging allows visualization of structures with very short T2. This work presents a new UTE implementation that achieves a TE of 8 µs. This order-of-magnitude reduction in echo time compared to previously reported 1.5-T UTE implementations holds promise for imaging of very short T2 components and provides a platform for exploration of resolution limits when imaging such tissues. Images and analysis characterizing performance with single-digit TE are presented.

**16:24**  **630. Scan Time Reduction for Ultrashort TE Imaging at 3T**  
*Christoph Schroeder*, *Juergen Rahmer*, *Peter Boernert*, *Christoph Leussler*  
1Philips Research Laboratories, Hamburg, Germany

A possible scan time reduction approach for imaging sequences at ultrashort echo times has been investigated. Usually, two half-sinc excitations per k-space line are required to excite a slice. Thus, each profile must be measured twice, which prolongs the scanning time. In this paper, it is shown that scanning time can be reduced for radial FID sampling schemes by measuring each profile only once and interleaving the half-sinc excitation pulses.

**16:36**  **631. Rapid Imaging using a 3D Cones Trajectory and Balanced SSFP**  
*Paul Gurney*, *Brian Hargreaves*, *Dwight Nishimura*  
1Stanford University, Stanford, California, USA

A 3D Cones trajectory allows for a large reduction in required interleafes as compared to 3DPR while still maintaining many of its desirable properties such as insensitivity to flow and motion. We discuss the tradeoffs and design decisions encountered when using a 3D Cones trajectory with Balanced SSFP.
16:48 632. **K-space Trajectory Errors: Dependence of View Ordering for ECG-Gated Radial TrueFISP Acquisitions**

Kestutis J. Barkauskas¹, Claudia M. Hillenbrand², Jonathan S. Lewin³, Jeffrey L. Duerk⁴
¹Case Western Reserve University, Cleveland, Ohio, USA; ²University Hospitals of Cleveland, Cleveland, Ohio, USA

Gradient delay compensation and reconstruction based on a measured trajectory have been proposed to account for trajectory errors. Data for cardiovascular applications are usually acquired with a rapid acquisition and ECG-gating. The purpose of this work is to establish if gradient delay compensation alone would be sufficient to correct trajectory errors in ECG-gated TrueFISP acquisitions with sequential or interleaved view ordering. Despite active gradient shielding, we conclude that eddy currents induced during the interleaved acquisition will require the use of a measured trajectory, along with gradient delay correction, for radial trajectories including those using interleaved segmented ordering schemes.

17:00 633. **Self-Navigated Motion Correction using Moments of Spatial Projections in Radial MRI**

Edward Brian Welch¹, Phillip J. Rossman¹, Joel P. Felmac², Armando Mandalua³
¹Mayo Clinic, Rochester, Minnesota, USA

Radial MR acquisitions have intrinsic advantages over 2DFT acquisitions when imaging moving objects. Many techniques have been proposed to further improve the robustness of PR against motion artifacts, however, it has not been realized previously that consistency properties of 2nd moments of the PR projections can directly detect in-plane rotation. Here we propose a correction algorithm with only one requirement beyond a standard PR acquisition, a specific view angle acquisition order, and demonstrate the approach with a resolution phantom, computer-controlled translational artifacts and rotation artifacts created by rotating imaging gradients. In all cases, the corrected images are dramatically improved.

17:12 634. **Filtered Backprojection, Regridding, and POCS Correction in Projection Reconstruction**

Kuan J. Lee⁴, Jim M. Wild⁴, Martyn N. Paley⁴, Iain D. Wilkinson⁴, Paul D. Griffiths¹
¹University of Sheffield, Sheffield, Yorkshire, UK

This work compares magnitude filtered backprojection (mFBP) versus regridding for projection reconstruction, and the use of POCS based algorithm to provide image-based correction for k-space miscentering such as that arising from gradient delays. Results: if the object has spatially uniform phase, then (a) mFBP is effective even with miscentering and (b) regridding is effective but miscentering results in artefacts, but may be corrected by POCS alignment. If the object has non-uniform phase, mFBP is ineffective and phased reconstruction is required. Miscentering in this case can also be corrected by POCS alignment.

17:24 635. **Moving-Buffer k-t BLAST for Real-Time Reconstruction: Cartesian and Simplified Radial Cases**

Jeffrey Tsao¹, Sebastian Kozerke¹, Michael S. Hansen², Holger Eggers³, Peter Boesiger⁴, Klaas P. Pruessmann¹
¹Swiss Federal Institute of Technology, Zurich, Switzerland; ²University of Aarhus, Aarhus, Denmark; ³Philips Research, Hamburg, Germany

k-t BLAST allows significant acceleration in dynamic imaging by exploiting spatiotemporal correlations. Since the method applies a Fourier transform along time to the acquired data, the straightforward implementation requires the reconstruction to start only after complete data collection. Here, we demonstrate the feasibility of on-the-fly reconstruction by replacing the Fourier transform with a short-time Fourier transform (STFT). Issues regarding the needed length and the latency of the STFT are addressed. Both Cartesian and radial k-space sampling is examined, and a simplified reconstruction is proposed for the latter to reduce computational load. Results from in vivo cardiac imaging are demonstrated.

17:36 636. **Ultrashort TE (UTE) Imaging of Short T₂ Relaxation Components: How Should the T₂ Weighting Be Described?**

Matthew D. Robson¹, Peter D. Gatehouse², Ian R. Young³, Graeme M. Bydder³
¹MRS Unit, Oxford, UK; ²Royal Brompton Hospital, London, UK; ³Imperial College, London, UK; ⁴University of California San Diego, San Diego, California, USA

Time to echo (TE) is an easy parameter to define for long T₂ samples using conventional spin-echo sequences and is a valuable measure of T₂ weighting. The issue is more complicated with FID sequences when no conventional echo is formed and when imaging species with short T₂s comparable in duration to the rf pulses used to excite them. In this paper we consider these issues, present results of simulations and provide a framework for further discussion.

17:48 637. **Rapid Evaluation of Cardiac Function Using Undersampled Radial TrueFISP with GRAPPA**

Mark A. Griswold¹, Martin Blaimer¹, Robin M. Heidemann¹, Peter Speier², Stephan Kannenberger², Matthias Nittka², Felix Breuer³, Matthias Mueller¹, Peter M. Jakob⁴
¹Universität Würzburg, Würzburg, Germany; ²Siemens Medical Solutions, Erlangen, Germany

In this abstract it is shown that it is possible to perform rapid real time cardiac functional imaging using an undersampled radial trajectory in combination with the GRAPPA parallel imaging reconstruction. GRAPPA improved image quality compared to the undersampled data set in each case tested to date. Parallel imaging accelerations of 3-6 were obtained, corresponding to a factor of 8-16 compared to full Cartesian sampling. A coil calibration strategy based on a prescan of several fully sampled frames proved to be an easy and robust solution for this application.
Functional and Pharmacological Brain Activation in Animals

Sakura  16:00 - 18:00           Chairs: Dorothée P. Auer and Michael Czisch

16:00  638.  Echo-Planar Imaging BOLD fMRI in Mice on a 9.4 T Vertical Bore Microimager
          Govind Nair\textsuperscript{1}, Timothy Q. Duong\textsuperscript{1}
          \textsuperscript{1}University of Massachusetts Medical School, Worcester, Massachusetts, USA

Functional MRI using echo-planar imaging (EPI) on high-field, small vertical-bore microimaging systems is relatively more challenging. In this study, we demonstrated that blood-oxygenation-level-dependent (BOLD) functional MRI using spin-echo EPI on a vertical 9.4 Tesla microimager can be used to robustly detect fMRI changes associated with hypercapnic challenge and electrical somatosensory stimulation in spontaneously breathing, isoflurane-anesthetized mice. Graded isoflurane levels and graded electrical somatosensory stimulation currents were explored. BOLD fMRI using EPI on cost-effective microimagers is expected to have widespread applications for investigating transgenic mice.

16:12  639.  Mn-Enhanced MRI (MEMRI) of Auditory Brain Activity in Unilaterally Deafened Mice
          Xin Yu\textsuperscript{1}, Youssef Zaim Wadghiri\textsuperscript{1}, Dan H. Sanes\textsuperscript{2}, Daniel H. Turnbull\textsuperscript{1}
          \textsuperscript{1}New York University School of Medicine, New York, New York, USA; \textsuperscript{2}New York University, New York, New York, USA

Previously, we demonstrated the utility of Mn-Enhanced MRI (MEMRI) for detecting sound-evoked neural activity in the mouse auditory system. In the current study, we investigated the developmental and longitudinal effects of conductive hearing loss (CHL) on auditory brain function, imaging unilaterally deafened mice with 3D T1-weighted gradient echo MRI after intra-peritoneal (IP) injection of MnCl\textsubscript{2} and 24h of exposure to broadband sound stimuli. We observed that CHL occurring before a critical early stage of auditory brain development produced more significant and persistent MEMRI enhancement, comparing functional and deafened sides of the brain, than hearing loss occurring after the critical period.

16:24  640.  A Comparison of Whole Brain Functional MR Images Obtained with BOLD and CBV Contrast during Somatosensory Stimulation in the Rat
          Shella D. Keilholz\textsuperscript{1}, Afonso C. Silva\textsuperscript{1}, Mira Raman\textsuperscript{1}, Hellmut Merkle\textsuperscript{1}, Alan P. Koretsky\textsuperscript{1}
          \textsuperscript{1}National Institutes of Health, Bethesda, Maryland, USA

Whole-brain fMRI has the potential to elucidate functional connections in the brain. Using an EPI sequence with interleaved slices that can cover the rat brain in 1.5 seconds, functional MR images with BOLD and CBV contrast were obtained in rats at 11.7T during stimulation of the forepaw. Activation was observed in SI, SII, thalamus, and cerebellum with both techniques. The location of the cerebellar activation was along the surface in the BOLD images, but deeper in the CBV images. The discrepancy may indicate increased sensitivity to draining veins in the BOLD images.

16:36  641.  Stimulus Specific Processing within Different Auditory Regions of the Songbird Brain during a Variety of Listening Tasks: Evidence from the BOLD Response
          Vincent Van Meer\textsuperscript{1}, Tiny Boumans\textsuperscript{1}, Geert De Groof\textsuperscript{1}, Johan Van Audenarde\textsuperscript{1}, Marleen Verhoeyen\textsuperscript{1}, Annemie Van der Linden\textsuperscript{1}
          \textsuperscript{1}University of Antwerp, Antwerp, Belgium

Recently we introduced fMRI in the songbird as a new tool to study cognitive processes based on their ability to recognize and learn songs. In this study we explore the BOLD response to a variety of auditory stimuli in different auditory regions. We found that the shape of the BOLD response is region and stimulus specific. This could reflect the differential processing strategies of the auditory regions involved or even of the entire auditory circuitry as a function of sound analysis, recognition and memory. The results nicely illustrate the usefulness of BOLD fMRI for imaging auditory brain circuits in songbirds.

16:48  642.  Increased GABA Concentration Correlates with Decreased fMRI Signals in Vigabatrin-Treated Anaesthetized Rat Brain
          Zhengguang Chen\textsuperscript{1}, Afonso C Silva\textsuperscript{1}, Jehoon Yang\textsuperscript{1}, Jun Shen\textsuperscript{1}
          \textsuperscript{1}National Institutes of Health, Bethesda, Maryland, USA

We report the effect of acute VGB treatment on the fMRI response to somatosensory stimulation in á-chloralose-anesthetized rats. Brain inhibitory neurotransmitter GABA was found to increase after VGB administration. Correlating with the spectroscopic results, we found significantly depressed fMRI response to forepaw stimulation in the somatosensory cortex in the VGB-treated group while in the control group the fMRI response had no significant variations. The present study suggests that the increased availability of cortical endogenous GABA caused by inhibition of GABA transaminase suppresses the fMRI signal intensity in anaesthetized rat brain.
Measurement of the Functional Actions of Ketamine in the Rat Brain using Locomotor Activity, Microdialysis and phMRI Imaging Techniques

Clare Louise Littlewood¹, Nicholas Jones¹, Stephen N. Mitchell², Mark D. Tricklebank², Michael J. O'Neill², Steven CR Williams²

¹Institute of Psychiatry, London, UK; ²Eli Lilly & Co. Ltd, Windlesham, Surrey, UK

Ketamine challenge in rats may form a model of some of the symptoms of schizophrenia. The current phMRI study aimed to measure spatial and temporal alterations in brain activity following an acute dose of ketamine (25 mg/kg s.c.) via changes in Blood Oxygen Level Dependent (BOLD) parameters. We report that MRI technology appears sensitive to the neural effects of ketamine, with changes in BOLD contrast correlating to the pharmcodynamic and neurochemical profile of the drug. The current data suggest that MRI may form a powerful tool for future research into schizophrenia and development of new antipsychotic medications.

Using fMRI to Elucidate the Pathways Responsible for Seizure Genesis in a Conscious Animal Model

Mathew E. Brevard¹, Craig F. Ferris¹

¹University of Massachusetts Medical School, Worcester, Massachusetts, USA

Advances in imaging conscious animals make it possible to map the functional neuroanatomy contributing to the genesis of seizures. Pentylenetetrazol was used to stimulate seizure activity within 30 sec while collecting images at sub-second intervals. From these data and from studies using ethosuximide to block seizure, the hippocampus, mammillary complex, anterior thalamus and anterior cingulate cortex were identified as key brain areas in PTZ seizure. In the presence of ethosuximide, the activation of the anterior thalamus and mammillary complex dissociated. The minimal activity in other cortical areas suggests these sites do not contribute to the genesis of these seizures.

fMRI Investigation of Glutamatergic Neurovascular Coupling in the Rat Brain

Vivienne Austin¹, Andrew Blamire¹, Michael J. O’Neill², Peter Styles¹, Paul Matthews¹, Nicola Sibson¹

¹University of Oxford, Oxford, UK; ²Eli Lilly and Co. Ltd., Windlesham, Surrey, UK

Glutamate has been suggested as a mediator of neurovascular coupling, potentially via an astrocytic mechanism. We have investigated the effects of an mGlu5 receptor antagonist, MPEP, on the fMRI response to direct cortical stimulation in the rat brain. We found the BOLD response was greatly reduced in the motor and secondary somatosensory cortices. Whereas it became predominantly negative in the contralateral structures, it was only reduced by half in the ipsilateral structures. In contrast, the response in the ipsilateral striatum was well preserved. This may reflect differing roles of mGlu5R in the neurovascular coupling mechanisms in these different brain regions.

The Relationship between Local Dopamine Changes and phMRI Response to Acute Cocaine Challenge in the Rat Revealed by Concurrent In Situ Microdialysis

Adam J. Schwarz¹, Alessandro A. Zocchi¹, Torsten Reese¹, Alessandro Gozzi¹, Giorgia Varnier¹, Elena Girlanda¹, Barbara A. Biscaro¹, Valerio Crestani², Simone Bertiani¹, Christian A. Heidbreder³, Angelo Bifone¹

¹GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; ²GlaxoSmithKline, Verona, Italy

The mechanisms underlying pharmacological MRI (phMRI) remain to be fully elucidated. To investigate the correlation between phMRI response and local neurochemistry, we report simultaneous changes in cocaine, dopamine and phMRI following cocaine challenge in the rat, using microdialysis samples obtained in situ at 5-minute intervals in several brain structures. In the striatum and pre-frontal cortex the local phMRI response profiles were broader and delayed relative to that of dopamine. In the motor cortex, no local change in dopamine occurred, despite a robust phMRI response, thus implying that the haemodynamic response to cocaine is not driven by local dopamine changes alone.

A Ceiling Effect of BOLD Responses to Theophylline Infusion in a Rat Model

Feng Luo¹, Marie L. Schulte¹, Janine Havnen², Anthony G. Hudetz², Shi-Jiang Li²

¹Medical College of Wisconsin, Milwaukee, Wisconsin, USA; ²University of Wisconsin, Madison, Wisconsin, USA

BOLD signals alteration under different baseline perfusion levels was observed. We employed theophylline, which is an adenosine-receptor antagonist in low dose, but a vascular dilator at high dose on a well-established rat forepaw stimulation model to test a hypothesis that BOLD signals would be constrained by global perfusion increase independent of neuronal activation. It is found that a high dose of theophylline increased CBF without perturbing the local field potential in the contralateral somatosensory cortex, however, a significant decrease in BOLD signals during forepaw stimulation. It is suggested a ceiling effect.
### Myofiber Architecture and Strain

**Annex 2** 16:00 - 18:00  **Chairs: Samuel A. Wickline and Dara L. Kraitchman**

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<tr>
<td>16:00</td>
<td>648</td>
<td>Initial Experience in Cardiac Fiber Detection Based on 3D Phase Contrast Velocity Data</td>
<td>Bernd André Jung¹, Björn Wolff Kreher¹, Jürgen Hennig²</td>
<td>¹University Hospital, Freiburg, Germany</td>
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This work investigates the correlation between the motion of the left ventricular wall and the cardiac fiber structure. The motion of the left ventricle was acquired with repeated single slice phase contrast measurements with 3D velocity encoding. A subsequent post processing evaluation with a tracking algorithm for the resulting velocity vectors, normally used for fiber tracking in diffusion weighted imaging, was performed in order to compare the pathways with known fiber structures of investigations of postmortem human hearts.

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<tr>
<td>16:12</td>
<td>649</td>
<td>Dynamic Alterations in Myocardial Fiber and Laminar Sheet Structure of Rat Hearts in Diastole and Systole Quantified by Diffusion Tensor MRI</td>
<td>Junjie Chen¹, Wei Liu¹, John Stacy Allen¹, Victor Song¹, Samuel A. Wickline¹, Xin Yu¹</td>
<td>¹Washington University, Saint Louis, Missouri, USA</td>
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The purpose of this study is to characterize alterations in myofiber and laminar sheet structure of heart in diastole and systole using diffusion tensor imaging. Transmural shift of myofiber helix angle at base, midventricle and apex increased from 103°±14°, 97°±12° and 100°±13° respectively at diastole to 132°±9°, 134°±9° and 133°±11° respectively at systole (p<0.001 for each pair of data). No significant changes were observed for transverse angle. In systole, the absolute value of sheet angle decreased by 19°±5°, 15°±4° and 16°±3° at base, midventricle and apex respectively.

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<tr>
<td>16:24</td>
<td>650</td>
<td>Reconstruction of 3D Myocardial Fiber Architecture using SENSE-DTI at 3 Tesla</td>
<td>Peter Schmid¹, Thomas Jaermann¹, Urs Gamper¹, Paul P. Lunkenheimer¹, Peter Boesiger¹, Peter Niederer¹</td>
<td>¹ETH and University Zurich, Zurich, Switzerland; ²University of Muenster, Muenster, Germany</td>
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The classical approach to determine the global myocardial fiber structure is time-consuming, destructive and strongly invasive. In this work we explore an alternative non-invasive technique based on Diffusion Tensor MRI (DTI). From ex-vivo porcine hearts, sensitivity encoded (SENSE)-images were acquired and muscle fibers were reconstructed using a custom-made tensor tracking algorithm. The excellent correspondence of papillary fiber orientation and the reconstructed 3D fibers for the whole heart were in accordance to previous histological examinations. It is concluded that DTI at high field strength incorporating parallel imaging allows accurate myocardial fiber reconstruction with reasonably short measurement times.

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<td>16:36</td>
<td>651</td>
<td>Regional Frank-Starling Effect Contributes to Larger Peak Strain in Lateral Free Wall in the Healthy Human Heart</td>
<td>Jaco J.M. Zwanenburg¹, Marco J.W. Götte¹, Joost P.A. Kuijer¹, Sandra R. Tecelao¹, J. T. Marcus¹</td>
<td>¹VU University Medical Center, Amsterdam, Netherlands; ²University of Lisbon, Lisbon, Portugal</td>
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We hypothesized that regional differences in peak strain in the healthy human left ventricle are caused by regional differences in the amount of prestretch due to the atrial contraction (regional “Frank-Starling”). Myocardial tagging and strain analysis was performed in 11 healthy volunteers, using SSFP imaging and HARP strain analysis. The averaged regional pattern of prestretch showed more prestretch in the lateral wall than in the septum (P < 0.001) and was similar to the averaged regional pattern in peakCS: Pearson correlation = 0.76, P < 0.001. Conclusion: LV-prestretch is not uniform and causes larger strain values in the lateral wall.

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<td>16:48</td>
<td>652</td>
<td>Consistent Strain Rate Mapping with MR Velocity Imaging</td>
<td>JianXin Gao¹, Sharmeen Masood², David N. Firmin¹, Guang-Zhong Yang¹</td>
<td>¹Imperial College, London, UK</td>
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This paper introduces a new method of improving strain rate computation from MR velocity mapping by discriminately utilising its components based on the incompressibility constraint. The relatively reliable through-plane velocity component is kept unchanged while its in-plane counterparts are changed iteratively during an optimization process which minimizes a mixed cost function consisting of an error term and residual divergence. Strain rates are calculated thereafter. Results from a synthetic dataset and real MR image datasets demonstrated consistent strain rate distributions across subjects, thus facilitating the production of a probabilistic atlas of normals that can be used to detect changes in disease.
Motion Analysis for Shortening Scan Times by Use of Affine Transformations and HARP in Cardiac MRI
Lars Ritsgaard Ribe, Michael Schacht Hansen, Steffen Ringgaard, Erik Morre Pedersen
Aarhus University Hospital, Aarhus, Denmark

Correction of motion artifacts in high-resolution cardiac MRI is possible if the motion may be described as an affine transformation. We present a new method for quantification of affine transformation components from per-pixel motion information using harmonic phase (HARP) imaging. We found that the motion of the left anterior descending coronary artery in a long axis slice was well described by an affine transformation through the entire cardiac cycle (83% of the motion is affine), and that the method has the potential for extending the 100ms time window used as standard to a time window of 450 ms in average.

Quantification of Myocardial Volume Change during Systole and Diastole using 3D-DENSE
Ignacio Rodriguez, Han Wen
National Institutes of Health, Bethesda, Maryland, USA

Contraction and relaxation results in periodic oscillations of the intramyocardial pressure, which is reported to cause a fluctuation of the vascular volume in the rat heart. The mechanism of this change can be either local water redistribution or global blood flow. The latter would cause the overall tissue volume to fluctuate accordingly. The volume change in three layers of the canine myocardium during systole and diastole has been measured using 3D-DENSE MRI in six closed-chest beagles. The results show a 1.6 % to 1.0 % volume decrease from endo to epicardial layers during systole, and a corresponding increase during diastole.

3D Tracking of Cardiac Material Points Using a Combined Slice-Following Harmonic Phase (SF-HARP) Magnetic Resonance Imaging Approach
Smita Sampath, Jerry L. Prince
Johns Hopkins University, Baltimore, Maryland, USA

We present an implementation that combines Slice Following and HARP MRI to track a grid of material points (MR markers) in three dimensions. Experimental data from eight short axis slices and four long axis slices was obtained using the SF-HARP pulse sequence. A sparse grid of material points at the lines of intersections of the short axis and long axis planes were selected and tracked independently on the two orthogonal 2D planes. For each point, the results were combined into a single 3D pathline representing the 3D motion of the MR marker.

Validation of 3D-HARmonic Phase (3D-HARP) for Cardiac Motion Estimation
Li Pan, Jerry L. Prince, Joao A.C. Lima, Nael F. Osman
Johns Hopkins University, Baltimore, Maryland, USA

3D-HARmonic Phase (3D-HARP) has been proposed as a fast and semiautomatic method for tracking 3D cardiac motion from short- and long-axis tagged MRI images. In this work, we validate 3D-HARP by comparing results to the well-established techniques, FINDTAGS and Tag Strain(E) Analysis (TEA), in motion tracking and strain computation. The correlation analysis of 3D-HARP and FINDTAGS+TEA shows that the regression coefficients of circumferential strain (Ecc) and twist angle are r²=0.86 and r²=0.86, respectively. A small motion between the reference time and the first timeframe can be examined by 3D-HARP, which is not available from FINDTAGS+TEA.

High Speed 3D CSPAMM
Salome Ryf, Christoph Baltes, Peter Boesiger
University and ETH, Zuerich, Switzerland

The objective of the current work was to accelerate data acquisition for 3D CSPAMM using a reduced sampling pattern only acquiring the eight signal peaks produced by 3D CSPAMM. This acquisition scheme allows obtaining a whole 3D CSPAMM data set in only four breath holds of 21 RR-intervals duration each. In initial in-vivo measurements good image quality was obtained. Thus, 3D CSPAMM may become applicable for larger volunteer or patient studies.
16:12 659. **Reduction of Peripheral Nerve Stimulation via the Use of Combined Gradient and Uniform Field Coils**

Silvia Sandra Hidalgo-Tobon1, Martin Bencsik2, Richard W. Bowtell1

1University of Nottingham, Nottingham, UK; 2Trent University, Nottingham, UK

Higher rates of change of gradient with time (dG/dt) can be achieved without causing peripheral nerve stimulation by reducing the rate of change of magnetic field occurring in regions of the body with a large cross section. Here we evaluate a novel approach to achieving such a reduction involving the application of a synchronously varying uniform field in conjunction with the field gradient. Coil pairs producing a y-gradient and uniform By-field, and a z-gradient and uniform Bz-field have been tested in volunteer studies. The results indicate that significantly larger dG/dt values can be achieved at PNS threshold using this approach.

16:24 660. **An Increase in Blood Viscosity in a Static Magnetic Field of a 1.5-T Magnetic Resonance Scanner**

Yuki Nagayama1, Toru Yamamoto2, Mamoru Tamura3

1Hokkaido University, Sapporo, Japan; 2Hokkaido University School of Medicine, Sapporo, Japan

As oxygenated hemoglobin is diamagnetic and deoxygenated hemoglobin is paramagnetic, red blood cells interact with the external magnetic field. However, the underlying mechanisms of the magnetic influence on blood viscosity are poorly understood and no evidence exists of an increase in blood viscosity at the 1.5 T of widely-used clinical MRIs. To address these questions, we measured the time for blood to fall through a glass capillary inside and outside a 1.5-T MR scanner. We report that the blood viscosity clearly increases in a 1.5-T MR scanner and the increase in blood viscosity is dependent on blood oxygenation.

16:36 661. **Significance of Applied Driving Voltage in Calculations of Electrical Fields in a Loaded Gradient Coil**

Christopher M. Collins1, Blaine A. Chronik2, Michael B. Smith1

1Penn State College of Medicine, Hershey, Pennsylvania, USA; 2University of Western Ontario, London, Ontario, Canada

Previous calculations of electrical fields induced by gradient coils in biological samples typically have relied on consideration of the electrical field induced by the changing magnetic field with no consideration of the “conservative” electrical field resulting from applied driving voltage, which is sometimes on the order of kV applied at one location in each coil. Here we present attempts to use the finite-difference time-domain (FDTD) method to examine the importance of modeling the voltage distribution in gradient coils. Initial results indicate that the “conservative” field results in significant electrical fields at the surface of the sample.

16:48 662. **Investigating RF Heating of Pacemakers in MRI using a Safety Index**

Onur Ferhanoglu1, Tonguc Onur Tasci1, AbdElMonem Mohamed El-Sharkawy2, Ayhan Altintas1, Ergin Atalar1

1Bilkent University, Ankara, Turkey; 2Johns Hopkins University, Baltimore, Maryland, USA

In this study, RF heating in a patient implanted with a cardiac pacemaker who was undergoing an MRI scan, was determined theoretically and verified experimentally. A safety limit was obtained on the specific absorption rate (SAR) of the radiofrequency (RF) pulse applied. This limit was found using the “safety index” to ensure tolerable temperature increases on such patients.

17:00 663. **Individual Prediction of a Temperature Rise of Guidewires during MR-Examinations using RF-Field Measurements: A Comparison of 1.5 and 3 T**

Ralf Girnus1, Frank Träber2, Jürgen Gieseke2, Volker Hesselmann1, Jürgen Banke1, Barbara Krug1, Hans Schild2, Klaus Lackner1

1University of Cologne, Cologne, Germany; 2University of Bonn, Bonn, Germany; 3Philips Medical Systems, Hamburg, Germany

During an MR-examination, electroconductive structures can couple with the E-field component of the rf-pulses. A consequence is the possibility of a temperature rise e.g. guidewires during interventions. Due to the inhomogeneity of the E-field and the variable geometric arrangement of the device inside the scanner, it is necessary to be able to perform an individual risk analysis. Measurements at wire and guidewire enclosed partly by a copper sulfate phantom at 1.5 and 3 T were done. It could be shown that changes of the rf-field around wires correlate with heating effect at wires.

17:12 664. **Non-Invasive MR Temperature Imaging for Temperature Control of Metallic Implants**

Jens-Christoph Georgi1, Sabine Heliland1, Guido Rademaker2

1University of Heidelberg Medical Center, Heidelberg, Germany; 2German Cancer Research Center (DKFZ), Heidelberg, Germany

The goal of our study was to assess the possibilities that non-invasive MR temperature imaging based on the proton resonance frequency shift method grant for the temperature monitoring for patients with metallic implants in clinical routine. It was tested if spatial, thermal, and temporal resolution comply with the requirements of patients safely control. The influence of deletions of the MR signal due to transitions in susceptibility at the implants was assessed. Our studies could demonstrate that non-invasive MR temperature imaging is a suitable method for temperature control. Spacial, thermal, and temporal resolution are high enough.
17:24 665. Assessment of SAR Values and Coil Performance for an Adaptive 4-Channel 3T Proton Head Coil Array
   Gerd Wuebbeler1, Frank Seifert1, Sven Junge2, Herbert Rinneberg1
   1Physikalisch-Technische Bundesanstalt, Berlin, Germany; 2Bruker BioSpin MRI, Ettlingen, Germany

At frequencies above 100 MHz pronounced distortions of the spatial B1-distribution occur in the body. An adaptive coil control scheme can be used for tailoring the B1-distribution by adjustment of amplitude- and phase-parameters of a coil array. In this case assessment of coil safety requires knowledge of the maximum local values of the specific absorption rate (SAR) for each set of amplitude and phase parameters. We apply a worst case analysis to simulated RF-field data, validated by B1-measurements, to assess the safety and the coil performance of a 4-channel transmit-receive head coil array operating at 125 MHz.

17:36 666. Numerical Evaluation of B1-Field and SAR for Heterogeneous and Homogeneous Body Model
   Zhiyong Zhai1, Gordon D. DeMeester1, Michael A. Morich1, Shmaryu M. Shvartsman1, Rob P. Kleihorst2
   1Philips Medical Systems, Cleveland, Ohio, USA; 2Philips Medical Systems, Best, Netherlands

A uniform body phantom is sought to study the electromagnetic behavior and SAR for high field systems. However, there are concerns that such a phantom cannot give results as accurate as a complex human body model with various tissues. To gain insight we use a FDTD method to numerically calculate the electric fields, magnetic fields, and SAR inside a homogeneous and a heterogeneous body model with identical external geometry at 128MHz/3T. Simulation suggests that a homogeneous phantom globally predicts electric and magnetic field distributions, but it may overestimate the whole body SAR and underestimate the local SAR in some regions.

17:48 667. RF Heating Comparison between Conductive and Resistive Wires in Interventional and Endoluminal MRI
   Cristina Armenean1, Mircea Armenean1, Emmanuel Perrin1, Olivier Beuf1, Frank Pilleul1, Hervé Saint-Jalmes1
   1Université Claude Bernard Lyon I, Villeurbanne, France

The interest for using metallic guide wire and catheter (e.g. nitinol) for interventional MRI or endoluminal MRI coils (e.g. copper) has considerably grown. The major issue is to insure patient safety against potential heating of tissues located in the wire vicinity. The purpose of this paper is to assess the differences between resistive and non resistive wires. The local concentration of the E field producing SAR around the wire is dominant for conductive wires, whereas for resistive wires the Joule effect increases the heating and changes the shape of temperature variation along the wire.

MR Imaging of Lung: Form and Function
Room B-1  16:00 - 18:00  Chairs: Qun Chen and Hirotu Hatabu

16:00 668. Pulmonary Blood Flow Heterogeneity During Hypoxia Measured with ASL-FAIRER in Subjects with Prior High Altitude Pulmonary Edema (HAPE)
   David L. Levin1, Joy Garg1, Divya S. Bolar2, Jamal Balouch1, Susan R. Hopkins1
   1University of California, San Diego, San Diego, California, USA; 2Harvard Medical School, Boston, Massachusetts, USA

High altitude pulmonary edema (HAPE) is a potentially fatal disease seen with travel to altitudes greater than 2500 m. Arterial Spin Labeling (ASL-FAIRER) was used to evaluate the heterogeneity of pulmonary blood flow resulting from 30 minutes of controlled hypoxia in subjects with (1) a history of HAPE, (2) extensive altitude exposure without HAPE, and (3) subjects without a history of altitude exposure. Subjects with a history of HAPE demonstrated an increase in blood flow heterogeneity not seen in the other groups. This supports the hypothesis that uneven hypoxic vasoconstriction is important in the development of HAPE.

   Olaf Dietrich1, Christoph Losert1, Ulrike Fasol1, Ulrike Attenberger1, Konstantin Nikolaou1, Stefan O. Schoenberg1, Michael Peller1, Maximilian F. Reiser1
   1Ludwig Maximilians University of Munich, Munich, Germany

The purpose of this study was to evaluate iPAT methods for oxygen-enhanced multi-slice lung imaging in combination with an optimized respiratory and cardiac triggering scheme. We studied 13 healthy volunteers using an Inversion Recovery HASTE sequence implemented on a 1.5 T whole-body scanner. We compared acquisitions with and without iPAT. The iPAT acceleration reduced the readout time from 214 ms without iPAT to 115 ms per slice. Thus, we could increase the number of acquired slices per respiration from 4 to 6 without prolongation of the examination. We did not observe any artifacts due to the iPAT reconstruction.
MR Screening for Lung Cancer
Daisuke Takenaka1, Yoshihiko Ohno2, Takanori Higashino2, Munenobu Nogami2, Hirokazu Watanabe2, Masahiko Fujii3, Kazuo Sugimura2
1Kasai Municipal Hospital, Kasai, Hyogo, Japan; 2Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan

Recent promising results of CT based-lung cancer screening studies have drastically grown the academic and public interest. However, improved sensitivity of CT screening is associated with higher-false positive rate. Some investigators have suggested that recent advanced MR imaging make it possible to detect small metastases. Moreover, many false-positive nodules with calcification and fibrosis were suggested to be invisible on MR imaging. Therefore, we hypothesized that MR had the potential as the tool for lung cancer screening, and may decrease false-positive rate. The purpose of this study is to determine the possibility of MR screening in lung cancer patients.

Measuring Quantitative Regional Lung Ventilation by Alveolar Ventilation Imaging (AVI) – Phantom Data and Results of a Feasibility Study in 50 Patients.
Hans Georg Topf1, Maren Wagner1, Rainer Kuth2, Peter Kreisler2, Michael Deimling2, Berhard Geiger3, Christopher Chefdhotel3, Thomas Rupprecht1
1University Erlangen, Erlangen, Germany; 2Siemens Medical Solutions, Erlangen, Germany; 3Siemens Corporate Research, Princeton, New Jersey, USA

Recently, a simple and fast true FISP thick slice imaging technique was developed to examine the lung parenchyma in 'real time' during the ventilatory cycle. Nonlinear registration of the pictures theoretically allows the calculation of the quantitative regional pulmonary ventilation. We present phantom results and measurements in 50 patients. The phantom study demonstrated a good correlation between real ventilation and the results of the MRI method. The measured values and the regional color coded ventilation maps were in concordance with the clinical expectations in all patients. Advantages of AVI are the avoidance external contrast agents, low cost, and simplicity.

Contrast Enhanced MR Angiography of the Pulmonary Circulation at 3.0T: Initial Experience with a Phased Array Coil.
Paul Finn1, Gerhard Laub2
1David Geffen School of Medicine at UCLA, Los Angeles, California, USA; 2Siemens Medical Solutions, Los Angeles, California, USA

Both time-resolved, and high-resolution MRA techniques have been implemented and optimized on a whole-body 3T MR imaging system. Initial results suggest that, with the use of low-SAR RF pulses, parallel acquisition strategies, and phased-array receiver coils, contrast-enhanced MRA of the lungs at 3.0T can provide dynamic, functional imaging with superior performance to 1.5T. For non-time-resolved MRA, high spatial resolution comparable to multi-slice CT is feasible.

Emphysematous Changes and Normal Variation in Smokers and COPD Patients using Diffusion 3He MRI
Andy Swift1, Jim Wild1, Stanislao Fichele1, Neil Woodhouse1, Roderick Lawson1, Martyn Paley1,
Edwin Van Beek1
1RHH, Sheffield, UK

This study aims to quantify global and regional changes of lung microstructure, using hyperpolarized 3-Helium MR apparent diffusion coefficient (ADC) measurement, in non-smokers, healthy (symptomatic) smokers, and COPD patients. Spirometry was performed on all subjects. Diffusion imaging was performed following hyperpolarized 3-Helium gas inhalation to produce regional ADC maps. Important differences in the regional and global ADC of healthy volunteers have been demonstrated and these results may have implications for the clinical interpretation of ADC changes in relation to lung diseases. These initial results suggest that early smoking related lung damage as well as more severe emphysema can be demonstrated.

3D Dynamic MR Perfusion Imaging: Quantitative Assessment of Disease Severity in Primary Pulmonary Hypertension Patients
Yoshihara Ohno1, Hiroto Hataba1, Kenya Murase1, Takanori Higashino1, Munenobu Nogami1, Daisuke Takenaka2, Masahiko Fujii3, Kazuo Sugimura3
1Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan; 2Osaka University Medical School, Suita, Osaka, Japan; 3Kasai Municipal Hospital, Kasai, Hyogo, Japan

Primary pulmonary hypertension (PPH) is a progressive disorder characterized by raised pulmonary vascular resistance (PVR). However, on clinical situation, perfusion scintigraphy has been only method for qualitative assessment of regional PVR changes. Recently, dynamic MR perfusion imaging have been suggested as useful for assessment of regional perfusion abnormalities. In the present study, we hypothesized that quantitative analysis of 3D MR perfusion imaging may evaluate the regional PVR changes in PPH patients as disease severity. The purpose of this study is to determine the capability of 3D MR perfusion imaging for quantitative assessment of disease severity in PPH patients.
Comparison of Pulmonary Perfusion Measurement by Dynamic Contrast-Enhanced MRI versus Perfusion Scintigraphy: Disagreement and Solution

Yi-Ru Lin¹, Ming-Ting Wu¹, Shiang-Yueh Tsai², Hsiao-Wen Chung¹, Kai-Sheng Hsieh¹, Nan-Jing Peng²
¹National Taiwan University, Taipei, Taiwan; ²Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan

Recently dynamic contrast-enhanced MRI (DCE-MRI) has been used to obtain quantitative pulmonary perfusion parameters and compared with lung perfusion scintigraphy (PS). Unlike the large-size Tc99M-MAA in PS mainly entrapped in pre-capillary intravascular space, Gd-DTPA in DCE-MRI may pass throughout the pulmonary circulation. To obtain comparable perfusion quantitation between DCE-MRI and PS, we proposed a new algorithm that only wash-in part of SI-time curve is considered. Our result showed that correlation between PS and DCE-MRI is rather low when entire curve is considered. However, they correlated well when wash-in part is considered, which supported hypothesis that PS only provides wash-in information.

Measurement of Regional Alveolar Ventilation in a Normal Mouse Model Using HP ³He MRI

Kiarash Emami¹, Martin C. Fischer¹, Christopher Van Besien¹, Gayatri Joshi¹, Meiqi Jiang¹, Jiangsheng Yu¹, Zebulon Z. Spector¹, Masaru Ishii², Thomas Connick¹, Stephen Pickup¹, Sheeva Rajaeei¹, Andrea Lo¹, Rey Panettieri¹, Angela Haczku¹, Rahim R. Rizi¹
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA; ²Johns Hopkins University, Baltimore, Maryland, USA

Regional ventilation deficiencies are symptomatic of many pulmonary disorders. A successful measurement of this quantity can be an effective tool in the early detection of such diseases. Regional ventilation measurement in a mouse is relatively difficult because of its very small tidal volume and high respiratory rate. Such a measurement is performed on a normal mouse using hyperpolarized ³He MRI as a baseline for further studies of simulated ventilation defects such as asthma.

Improved Quantitative Regional Oxygen-Enhanced MR Imaging of the Lung using Image Registration

Josephine H. Naish¹, Geoff JM Parker¹, Paul CW Beatty¹, Alan Jackson¹, John C. Waterton², Chris J. Taylor¹
¹University of Manchester, Manchester, UK; ²AstraZeneca, Macclesfield, UK

Inhaled oxygen acts as a paramagnetic contrast agent and allows regional assessment of lung ventilation. Here we present a method to determine regional oxygen induced changes in T₁ and signal intensity in the lungs using a simple image registration method. A reduction in breathing artefact is demonstrated for both T₁ maps and dynamic oxygen uptake and washout curves. Oxygen uptake times have been calculated by fitting to an exponential both in large regions of interest and locally. The image registration method is an improvement over retrospective respiratory gating and allows a greater temporal resolution to be achieved.

Spectroscopic Localization and Editing Techniques

Room B-2  16:00 - 18:00  Chairs: Oded Gonen and Dikoma Shungu

Fast CT-PRESS Based Spiral CSI at 3 T

Dirk Mayer¹, Dong-Hyun Kim¹, Elfar Adalsteinsson¹, Daniel M. Spielman¹
¹Stanford University, Stanford, California, USA

A new pulse sequence which combines Constant Time PRESS with spiral chemical shift imaging (CSI) was implemented on a 3 T MR scanner. This allows the acquisition of multi-voxel spectroscopic data without line splitting at a minimum total measurement time as short as 5 min. The sequence was tested on a phantom containing various metabolites and healthy volunteers. By using effective decoupling this work demonstrates that compounds such as glutamate and myo-inositol can be reliably measured without water or lipid baseline artifacts which typically hamper short TE CSI.

A New Method for Proton Detected Carbon Edited Spectroscopy Using LASER

Malgorzata Marjanska¹, Pierre-Gilles Henry¹, Rolf Gruetter¹, Michael Garwood², Kamil Ugurbil¹
¹University of Minnesota, Minneapolis, Minnesota, USA

Recent studies have shown that ¹³C MR can provide information about tissue energetics including the rate of the neurotransmission as mediated by the most abundant neurotransmitter, glutamate. One of the approaches used for monitoring ¹³C is indirect detection through ²H due to the gains in sensitivity. Here we propose a new method, a modified LASER sequence, for the purpose of performing indirect detection of ¹³C. The proposed LASER-based editing sequence retains the single-shot localization of ACED-STEAM while combining it with the advantage of the full sensitivity of a fully adiabatic editing sequence.
Single-Shot 3D Localized Indirect $^{13}$C Detection
Atiyah Yahya1, Peter S. Allen1
1University of Alberta, Edmonton, Alberta, Canada

Indirect $^{13}$C detection has been used in a number of MRS studies to measure metabolic fluxes using localization sequences incorporating the POCE technique; a technique which relies on the subtraction of alternate scans in order to suppress signal from protons not coupled to $^{13}$C nuclei. We demonstrate here that $^{13}$C coherences can be detected indirectly in a single scan and still suppress signal from protons not coupled to $^{13}$C nuclei by combining the PRESS localization sequence with a heteronuclear gradient sequence. The efficacy of the sequence was verified on phantoms containing acetic acid and glutamate.

Uncovering Hidden In Vivo Resonances Using 1D-TOCSY-LASER Spectroscopy
Malgorzata Marjanska1, Pierre-Gilles Henry1, Patrick J. Bolan1, Rolf Gruetter1, Kamil Ugurbil1, Michael Garwood1
1University of Minnesota, Minneapolis, Minnesota, USA

Low concentration metabolites in in vivo proton NMR spectra are often obscured by very strong resonances, e.g. glucose by water and lactate by lipids (in tumors). We demonstrate here that polarization transfer between coupled spins can be used for detection of resonances under strong overlapping signals. The considerably weaker signal of $\beta$-glucose is detected under water. This new single shot technique can be potentially used for detection of any metabolites that have J-coupled partners.

Sequence Design Incorporating the LASER Technique for Prostate MRSI at High Field
Charles H. Cunningham1, Malgorzata Marjanska1, Albert P. Chen1, Duan Xu1, John M. Pauly1, Napapon Sailasuta1, Ralph E. Hard3, John Kurhanewicz1, Michael Garwood2, Daniel B. Vigneron3
1Stanford University, Stanford, California, USA; 2University of Minnesota, Minneapolis, Minnesota, USA; 3UC San Francisco, San Francisco, California, USA; 4GE Medical Systems, Menlo Park, California, USA

High field (>=3T) systems offer a number of advantages for MR spectroscopic imaging (MRSI) of prostate cancer, including improved spectral resolution and increased sensitivity. However, measurement of citrate concentration is complicated by the J-modulation of the citrate resonances at 2.6ppm. With PRESS at TE=95ms, citrate is maximally inverted but this results in quantification issues. In this abstract, we describe our effort to address this problem with pulse-sequences designed to inhibit J-modulation. This study demonstrates the feasibility of acquiring citrate spectra immune to J-modulation effects by employing the LASER train of spatially-selective adiabatic refocusing pulses.

Unequivocal Detection of Glutathione in the Human Brain In Vivo Using Navigated Chemical Shift Imaging of Glutathione: Assessment of Regional Heterogeneity of Glutathione
In-Young Choi1
1The Nathan Kline Institute, Orangeburg, New York, USA

It is known that the distribution of GSH in the human brain is heterogeneous. However, the distribution of GSH has been addressed by invasive methods so far. Therefore, we developed a noninvasive method to address regional distribution of in vivo GSH using selective MQ GSH CSI with navigator CSI for phase correction and demonstrated unequivocal detection of the in vivo GSH throughout the entire CSI slice in the human brain at 3 Tesla. We also report for the first time the heterogeneous distribution of GSH in the living brain and the T1 value of in vivo GSH.

Detection of Glutamate at 3T with a Chemical Shift Selective Filter
Rolf F. Schulte1, Andreas H. Trabesinger1, Peter Boesiger1
1University and ETH Zurich, Zurich, Switzerland

One and two dimensional chemical shift selective filtering (CSSF) has been implemented and validated for the unequivocal detection of glutamate in vivo at 3T. This type of filter requires only the chemical shift of the resonances to be resolved and not the entire multiplets. Hence it is especially well suited for the detection of coupled resonances, as demonstrated in vitro and in vivo.

Single-shot 3D Localized Multiple Quantum Spectroscopy of GABA in the Human Brain In Vivo with Two Double-Band Pulses for Enhanced Selectivity
In-Young Choi1, Sang-Pil Lee1, Jun Shen1
1The Nathan Kline Institute, Orangeburg, New York, USA; 2National Institutes of Health, Bethesda, Maryland, USA

To enhance the selectivity of in vivo GABA measurements, a novel multiple quantum filtering method is developed that uses two double-band spectrally selective pulses in combination with a slice-selective 90°, a slice-selective universal rotator 90°, and a spectrally semi-selective and slice-selective 90° pulses composed of two universal rotator 45° pulses for single-shot 3D localization in multiple quantum filtering. The improved selectivity of GABA and suppression of other signals including water were demonstrated in phantoms and in humans.
Reproducibility of In-Vitro GABA Measurements using 2D J-Resolved MRS

In-Young Choi¹, Sang-Pil Lee¹, Jun Shen²
¹The Nathan Kline Institute, Orangeburg, New York, USA; ²National Institutes of Health, Bethesda, Maryland, USA

α-aminobutyric acid (GABA) is the major inhibitory neurotransmitter of the central nervous system, and may play a role in various neurological and psychiatric disorders. Attempts to measure GABA, in-vivo, are difficult due to GABA’s low physiological concentration (0.5 - 1.5 mM) and the presence of high concentration metabolites such as creatine and glutamate, which overlap GABA at low field strengths. This study evaluates the reproducibility of varying concentrations of GABA, down to 1.2 mM, across 150 in-vitro experiments, using a 2D J-resolved PRESS sequence at 1.5T, in both a volume head coil and a 5" General Purpose surface coil.

Broadband Decoupled and Single Voxel Localized 2D MR Spectroscopy

Hyun Chung¹, Shida Banakar², M. Albert Thomas²
¹GE Medical Systems, Waukesha, Wisconsin, USA; ²David Geffen School of Medicine at UCLA, Los Angeles, California, USA

Two different versions of a single volume localizing 2DMRS sequence based on constant time and homonuclear decoupling along one of the spectral dimensions (CT-PRESS) has been implemented on a 1.5T MRI/MRS scanner. A GAMMA simulation library was used to simulate the 2D spectra of non-localized version of these sequences. Phantoms containing different cerebral metabolites and the simulated 2D spectra were used to optimize the performance of these sequences. The 2D spectra were also recorded in the brain of six healthy human volunteers. Our preliminary results in human brain include 2D COSY-type spectra with homonuclear decoupling along the second dimension.
MORNING CATEGORICAL COURSE
Functional Body MR: From Morphology to Function

Sakura
07:00 – 08:00
Chairs: Riccardo Manfredi and Carlo Bartolozzi

Educational Objectives
Upon completion of this course, participants should be able to:
• Evaluate new pulse sequences based on knowledge of current MR technique, and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Incorporate recent developments for MR imaging such as MRCP for the pancreas and biliary tract, and MR diffusion and perfusion techniques for kidneys;
• Apply new contrast agents in different hepatic diseases;
• Evaluate the possibility of MR imaging in bowel imaging and in screening oncologic patients for metastatic disease;
• Achieve functional information reflecting physiologic processes.

07:00  Bowel
David J. Lomas

07:30  Breast
Francesco Sardanelli

MORNING CATEGORICAL COURSE
Understanding Diffusion Imaging and Functional MRI: The Relationship between Structure and Function in the Brain

Room A
07:00 – 08:00
Chairs: Gareth J. Barker and R. Todd Constable

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain how the fMRI data are acquired and processed;
• Explain how the diffusion tensor is acquired, measured and mapped;
• Define the terms structural and functional connectivity;
• Describe sources of artifacts, limitations to the data, and the likely impact of new parallel imaging techniques on fMRI and DTI data;
• List methods available to combine the complementary information from fMRI and DTI data.

The final five minutes of each presentation will be reserved for questions.

Quantitative Measures/Information Obtained
07:00  DTI: b-Values, Fractional Anisotropy and other Quantitative Measures
Peter J. Basser

07:30  fMRI/DTI - Combining Data
Mark R. Symms

MORNING CATEGORICAL COURSE
Echo Management

Room D
07:00 – 08:00
Chairs: Kim Butts and Scott D. Swanson

Educational Objectives
Upon completion of this course, participants should be able to:
• Explain the basic principles of spin echo, gradient echo, and stimulated echo formation;
• Appreciate the complexity of coherence pathways that arise when two or more RF pulses are applied;
• Describe methods that investigators use to mitigate effects of multiple coherence pathways to assure formation of proper echoes;
• List techniques used in steady-state free precession (SSFP) pulse sequences to minimize spurious echo formation;
• Determine which sequence will be appropriate for what clinical application.

07:00 Fully Refocused SSFP
Klaus Scheffler

07:25 Setting Up the steady State in SSFP
Brian A. Hargreaves

07:50 Discussion

MORNING CATEGORICAL COURSE
Established and Evolving Applications of MR Angiography

Annex 2 07:00 – 08:00 Chairs: J.F.M. Meaney, M.R. Prince, S.O. Schoenberg

Educational Objectives
Upon completion of this course, participants should be able to:
• Define the established indications for MRA;
• Recognize the importance of non-contrast and contrast-enhanced approaches in the different vascular territories;
• Diagnose common vascular pathology and variants;
• Apply the different post-processing algorithms to enhance diagnostic practice;
• Perform basic vessel wall imaging.

Carotic MRA
07:00 Optimization of Non-contrast Techniques
Dennis L. Parker

07:20 Contrast-Enhanced MRA
John Huston

07:40 Plaque Imaging and Characterization
Chun Yuan

MORNING CATEGORICAL COURSE
New Horizons in Musculoskeletal Imaging: Optimizing MRI With Current Technology

Room B-1 07:00 – 08:00 Chairs: Joshua M. Farber and Lawrence M. White

Educational Objectives
Upon completion of this course, participants should be able to:
• Describe MR techniques for imaging cartilage at various field strengths and understand the clinical role of MRI in the evaluation of articular cartilage disorders;
• Assess the musculoskeletal system using high and low field MR systems;
• Explain and use fat suppression MRI techniques in the musculoskeletal system;
• Explain and use fast scanning MRI techniques in the musculoskeletal system;
• Apply knowledge of high resolution MRI, and its trade-off with signal-to-noise, to imaging the musculoskeletal system;
• Describe the rationale of protocol approaches and apply this understanding to optimize MRI clinical protocols.

07:00 Spatial Resolution and SNR Considerations in MRI of the Musculoskeletal System
Garry E. Gold
07:25 **Optimizing Clinical Protocols in MRI of the Musculoskeletal System**  
*William B. Morrison*

07:50 **Discussion**

**MORNING CATEGORICAL COURSE**

**Parallel Imaging 2004**

*Annex 1 07:00 – 08:00*  
*Chairs: Neil M. Rofsky and Daniel K. Sodickson*

**Educational Objectives**

Upon completion of this course, participants should be able to:
- Explain the basic principles of parallel imaging, including elements both of RF coil array design and image reconstruction;
- Critically survey promising applications of parallel MRI;
- Summarize recent research into the limits of performance of parallel imaging, describe new developments in image reconstruction and coil array design, and outline emerging parallel imaging applications;
- Identify the key steps in a practical parallel imaging examination, and compare the nuts-and-bolts features of various MR vendors’ existing implementations.

**Vendor Update 2004**

07:00 **Recap of Basics, Applications & New Developments**  
*Daniel K. Sodickson*

07:05 **Philips Medical Systems**  
*Johan van den Brink*

07:15 **GE Medical Systems**  
*Kevin F. King*

07:25 **Siemens Medical Solutions**  
*Berthold Kiefer*

07:35 **Toshiba**  
*Kazuya Okamoto*

07:45 **Hitachi**  
*Tetsuhiro Takahashi*

07:55 **Discussion and Conclusions**

**MORNING CATEGORICAL COURSE**

**MR Spectroscopy: The Brain and Beyond**

*Room B-2 07:00 – 08:00*  
*Chairs: Peter S. Allen, John R. Griffiths, Rolf Gruetter*

**Educational Objectives**

Upon completion of this course, participants should be able to:
- Describe the principles of spectral analysis through LC modeling;
- Outline the mechanisms for intra-sequence signal loss when target metabolites have coupled spins;
- List the key metabolites facilitating the spectroscopic recognition of tumor development in the prostate and the brain;
- Outline how water can be used as an internal concentration standard with minimal associated spectral artifacts;
- Explain how macromolecular contamination of spectra can be recognized and mitigated;
- Explain how MRS can be used to reflect metabolic processes in muscle using glycogen or lipids.
**PLENARY LECTURES**

**Extending the Limits of MRI: New Concepts for Signal Detection and Enhancement**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
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<tbody>
<tr>
<td>8:15</td>
<td>688.</td>
<td><strong>Signal Detection in NMR: Macroscopic, Microscopic, and Nanoscale</strong></td>
<td>James Tropp&lt;sup&gt;1&lt;/sup&gt;</td>
<td>GE Medical Systems, Fremont, California, USA</td>
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<tr>
<td>8:40</td>
<td>689.</td>
<td><strong>&quot;Lighting Up&quot; NMR and MRI</strong></td>
<td>Alexander Pines&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Lawrence Berkeley National Laboratory and University of California, Berkeley, California, USA</td>
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<tr>
<td>9:05</td>
<td>690.</td>
<td><strong>Beyond Relaxation Contrast: Agents for Polarization Enhancement in MRI</strong></td>
<td>J. Steffan Petersson&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Amersham Health, Malmö, Sweden</td>
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Practitioners of biomedical NMR—while diversified in their backgrounds and interests—face nonetheless one problem in common: the inherent weakness of the NMR signal. This limits our spatial resolution, or more simply, the number of spins we can detect. We therefore pose the questions: what are the current limits of detection, and how may they be extended? Several methods are discussed, including the polarization transfer in noble gases and of Carbon-13, which promise improvements in Signal to Noise Ratio of factors approaching 10,000, and open the way for new and unsuspected applications.

The enhanced signals of laser-polarized gases allow novel applications of NMR and MRI in chemistry, biology, and medicine over distance scales from nanometers to meters. Two recent experiments use polarized atoms in "functionalized" molecular biosensors, and permit the observation of NMR and MRI in ultralow magnetic fields. Novel methodologies also allow "ex-situ," and even "remote," detection of magnetic resonance, making it possible to obtain enhanced information about samples, objects or subjects that are immobile or otherwise inaccessible to traditional methods of magnetic resonance spectroscopy and imaging in biomedicine.

Two 13C polarization techniques have been developed. The achieved degree of polarization, measured after dissolution in water, was > 35% - a factor 105 above the thermal equilibrium polarization at 1.5 T. The 13C image quality was evaluated in a series of animal experiments performed in a 1.5 T scanner using a true-FISP pulse sequence. The generated images demonstrate a high CNR indicating that this new class of hyperpolarized CM may be used to visualize parts of the vascular system, including the coronary arteries, together with physiological parameters (e.g. perfusion information) during MRI.

**Novel Sequence Design and Optimization**

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<th>Session</th>
<th>Title</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
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<tbody>
<tr>
<td>10:30</td>
<td>691.</td>
<td><strong>PETAL Imaging for Reduced Flow Sensitivity Compared to Spiral Methods</strong></td>
<td>James G. Pipe&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Barrow Neurological Institute, Phoenix, Arizona, USA</td>
</tr>
</tbody>
</table>

A new k-space trajectory for data collection is presented which balances the scan efficiency of spiral imaging with the flow insensitivity of projection reconstruction methods. The new method, termed Parallel Encoded Triangles in an Azimuthal Lattice (PETAL) imaging, is roughly 1/2 as efficient as spiral imaging, but should exhibit greatly reduced flow sensitivity at the edges of k-space. Simulations and an example image of 2D TOF PETAL imaging in the carotid arteries is shown.
10:42 692. Accurate Slice Reconstruction in 3D MRI Using Controlled Dephasing in SSFP Imaging

Christof Baltes¹, Michael Schaefer², Sebastian Kozerke³, Jeffrey Tsao¹, Peter Boesiger¹
¹University and ETH, Zurich, Switzerland

In 3D MRI, Fourier encoding is commonly applied to resolve distinct slices. However, adjacent slices suffer from significant signal cross-talk, which is particularly problematic for a small number of phase-encode steps. In this work, we describe a new approach based on Hadamard encoding and the off-resonance behavior of steady-state-free-precession imaging. Controlled spin dephasing is used to generate different Hadamard encoding steps. This approach results in reduced signal contamination and more distinct slice profiles compared to conventional Fourier encoding with the same number of encoding steps. Simulations, phantom and preliminary in vivo results are demonstrated.

10:54 693. Automatic Flip Angle Calculation for Consistent Contrast

Reed F. Busse¹
¹GE Medical Systems, Menlo Park, California, USA

In Spoiled Gradient Echo sequences the two parameters which determine contrast, repetition time (TR) and flip angle, interact in a non-linear manner which is often difficult to intuit. We demonstrate a means to flip angle such that when TR is changed, signal scales equally in all tissues, independently of T1 and proportionally to sqrt(TR). This allows TR to be varied freely to accommodate a range of sequence parameters such as number of slices, resolution and bandwidth without impacting relative contrast.

11:06 694. Low SAR Inversion Recovery Weighted TSE Sequences using TRAPS: Parameter Optimization and Examples

Matthias Weigel¹, Juergen Hennig¹
¹University Hospital Freiburg, Freiburg, Germany

Inversion recovery weighted TSE sequences are of great importance in diagnostic and clinical routine MRI. Recently, novel acquisition techniques for TSE sequences such as hyperechoes and TRAPS have been proposed to overcome the problem of high rf power depositions which are a general major drawback of TSE sequences. This contribution shows that such hypertSE sequences can also successfully produce high quality IR weighted images, but with a significantly reduced SAR compared to TSE180. Both, results of theoretical calculations for parameter optimization and first experiments are presented for three common types of IR weighted TSE sequences (T2 weighted STIR, FLAIR, GM/GM-IR).

11:18 695. Efficient Spatially-Selective Single-Slab 3D Turbo-Spin-Echo Imaging

John P. Mugler, III¹, James R. Brookeman¹
¹University of Virginia, Charlottesville, Virginia, USA

The echo-train efficiency (i.e., number of echoes collected per unit time during the echo train) of single-slab 3D spin-echo-based imaging can be increased significantly by using short, non-spatially-selective RF pulses for both excitation and refocusing instead of conventional section-selective pulses. However, this approach sacrifices the ability to perform slab selection and thus substantially limits the range of clinical applications. We have developed a simple and robust approach for spatially-selective single-slab 3D-TSE imaging that provides a high-quality slab profile and that permits non-selective, variable-flip-angle refocusing RF pulses to be used to achieve very short echo spacings and long echo-train durations.

11:30 696. Asymmetric Echoes for Robust Fast Spin-Echo “Dixon” Water-Fat Separation

Scott B. Reeder¹, Zhifei Wen¹, Huanzhou Yu¹, Angel R. Pineda¹, Ann Shimakawa², Jean H. Brittain², Garry E. Gold¹, Christopher F. Beaulieu¹, Norbert J. Pelc¹
¹Stanford University, Stanford, California, USA; ²GE Medical Systems, Menlo Park, California, USA

Application of “Dixon” fat-water separation with Fast Spin-Echo (FSE) imaging has experienced increasing popularity as an alternative fat-suppression method because of its high SNR and relative insensitivity to field inhomogeneities. Most FSE-Dixon acquisition schemes acquire three echoes symmetrically about the spin-echo. A recent noise analysis has shown that the noise performance of decomposition with symmetric echoes deteriorates when water and fat are found in equal proportions. This creates irregular water-fat interfaces and structured noise within tissues containing water and fat. Through careful selection of asymmetrically acquired echoes, artifacts at water-fat interfaces and structured noise in tissues containing water and fat are reduced.

11:42 697. T3ρ-weighted Spin-lock MRI

Andrew James Wheaton¹, Matthew Corbo¹, Arijitt Borthakur¹, Ravinder Reddy¹
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

T3ρ, the transverse relaxation in the rotating frame which can be approximated as the reciprocal average of T1 and T2, has potential for use as a novel means of generating T2-like contrast that contains both T2 and T1 information. A T3ρ-weighted sequence was implemented on a clinical scanner by applying a spin-lock pulse prior to slice-selective excitation. A T3ρ-map of a healthy human brain showed increased differentiation between structures that were not evident on a T2 map. The T3ρ-technique can also be used to increase contrast-to-noise in comparison to standard T2-weighted scans.
Time Efficient Triple Contrast Acquisition in Double Inversion Fast Spin Echo
Seong-Eun Kim1, Eugene Kholmovski1, K. Craig Goodrich1, Eun-Kee Jeong1, Dennis L. Parker1
1University of Utah, Salt Lake City, Utah, USA

The aim of the present study was to obtain multiple contrast images using double inversion magnetization preparation within one scan. Compared with previous approaches at increasing the efficiency of double inversion FSE techniques, the technique presented here allows improved imaging efficiency with the additional acquisition of T1 contrast images. The extra T1 contrast images, which are acquired with no increase in scan time, may provide improved information for evaluation of size and morphology of plaque in the carotid artery.

RF pulses with Built-In Saturation Sidebands
Charles H. Cunningham1, Jeffrey A. Stainsby2, John M. Pauly1, Juan M. Santos1, J. Andrew Derbyshire3, Graham A. Wright4
1Stanford University, Stanford, California, USA; 2University of Toronto, Toronto, Ontario, Canada; 3National Institutes of Health, Bethesda, Maryland, USA

Normally, the signal enhancement due to freshly magnetized blood flowing into the imaging slice is a desirable effect in MR angiography. However, when the goal is to detect the arrival of a bolus of gadolinium-DTPA, the signal variation due to in-flow is a source of uncertainty. This is a particular issue in applications such as auto-triggered MR angiography where the statistics of the signal are used to automatically determine contrast arrival. In this abstract we present the design and implementation of RF pulses that simultaneously excite a slice and de-phased saturation slabs, allowing saturation of blood without increasing TR.

Development of Multi-Contrast Sequences Using Continuous Moving Table Acquisition
Gregor Sommer1, Ute Ariane Ludwig1, Matthias Weigel1, Nadir Ghanem1, Jürgen Hennig1
1University Hospital Freiburg, Freiburg, Germany

An axial multi slice imaging technique with continuous table movement providing different contrasts for each slice is presented. The acquisition is based on a gradient echo sequence using different flip angles for all three slices (10°, 30°, 80°). The protocol yields three independent sets of axial images, each set with a different contrast and a gapless homogenous coverage of the whole human body.

Coronary MR Imaging
Room A 10:30 - 12:30 Chairs: Debiao Li and Matthias Stuber

Three-Dimensional Breath-Hold Coronary MRA: A Comparison Between 1.5T and 3.0T Using SSFP Sequence
Xiaoming Bi1, Vibhas Deshpande2, Orlando Simonetti2, Gerhard Laub2, Debiao Li1
1Northwestern University, Chicago, Illinois, USA; 2Siemens Medical Solutions, Erlangen, Germany

In theory, the SNR should be doubled at 3.0T as compared to 1.5T. However, B0 and B1 field inhomogeneities, alterations in tissue T1 and T2 may deflect the linear relationship between SNR and field strength. This study compared the SNR and CNR of coronary MRA between 3.0T and 1.5T using a 3D, breath-hold SSFP sequence. Good quality coronary images were acquired at both field strengths. Using the same coil and protocol settings, SNR and CNR were markedly improved at 3.0T. The study shows coronary MRA at 3.0T using SSFP method is very promising, which warrants further technical improvements and evaluations.

Continuous Epicardial Fat Suppression for Coronary MRA using Balanced FFE with Long Cardiac Acquisition Windows - A Comparison of Two Techniques
Christian Stehning1, Peter Börnert2, Kay Nehrkötter3, Olaf Dössel4
1University of Karlsruhe, Karlsruhe, Germany; 2Philips Research Laboratories, Hamburg, Germany

Suppression of epicardial fat is essential to improve the vessel depiction in coronary MRA. For this purpose, fat saturation is commonly applied prior to signal sampling. However, if long cardiac acquisition windows are used for increased scan efficiency, fat signal recovery during sampling causes image quality losses. This work investigates two continuous fat suppression techniques for balanced FFE sequences with long cardiac acquisition windows applied in coronary MRA. The first method is based on multiple saturation pulses during sampling, while the second technique locates and eliminates fat voxels retrospectively. The achieved fat suppression and image quality are compared.
Towards Whole Heart Coverage in a Single Breath-Hold: Coronary Artery Imaging Using a True 32-Channel Phased Array MRI System

Thoralf Niendorf¹, Daniel K. Sodickson², Christopher J. Hardy³, Robert D. Darrow³, Randy O. Giaquinto³, Manojkumar Saranathan⁴, Yudong Zhu⁵, Gontran Kenwood³, Michael Harsh⁶, Thomas K. Foo⁷

¹GE Medical Systems, Boston, Massachusetts, USA; ²Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA; ³GE Global Research Center, Niskayuna, New York, USA; ⁴GE Medical Systems, Baltimore, Maryland, USA; ⁵GE Medical Systems, Waukesha, Wisconsin, USA

The feasibility of rapid single-breath-hold coronary artery imaging using 32 independent receive coil elements, which is beyond that currently used in clinical applications, has been demonstrated. Uni- and bi-dimensional parallel imaging strategies using up to 8-fold acceleration were incorporated into a 3D FIESTA imaging technique, aimed at the acquisition of large imaging volumes, covering both the left and right coronary arterial systems without exceeding clinically acceptable breath-hold times.

Clinical Feasibility of Whole Heart Coronary MRA using a Navigator-gated 3D bTFE Sequence

Yasutaka Ichikawa¹, Hajike Sakuma¹, Naohisa Suzawa¹, Mikinori Nagata¹, Katsutoshi Makino¹, Tadanori Hirano¹, Kan Takeda¹, Nozomu Koyama¹, Marc van Cauteren¹

¹Matsusaka Central Hospital, Matsusaka, Mie, Japan; ²Mie University Hospital, Tsu, Mie, Japan; ³Philips Medical Systems, Minatoku, Tokyo, Japan

High-resolution whole heart coronary MR angiographic images were acquired in 21 patients with a navigator-gated 3D b-TFE sequence. The averaged imaging time to cover the entire coronary arteries was 18.0 ± 5.3 min. Excellent 3D MRA images of the entire coronary tree were obtained in 18 of 21 subjects (86%). A Soap-Bubble tool allows rapid delineation of the proximal coronary arteries, and 3D volume rendering is useful for delineating distal coronary arteries. Whole heart coronary MRA can provide a reliable 3D visualization of the major coronary arteries in a clinical setting.

Comparison of Cartesian and Radial SSFP Coronary MRA

Tim Leiner¹, Ernest N. Yeh², George Katsimaglis², Kraig V. Kissinger², Warren J. Manning², René M. Botnar²

¹Maastricht University Hospital, Maastricht, Netherlands; ²Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

Cardiac and respiratory motion hamper coronary MRA. Recently, a lot of attention has been directed towards steady-state free precession (SSFP) balanced TFE (bTFE) coronary MRA using Cartesian and radial k-space sampling. In the current study we investigated the sensitivity of Cartesian and radial k-space filling to bulk cardiac motion by acquiring coronary MR angiograms with three different acquisition windows (70/140/210 ms per cardiac cycle). When radial k-space sampling was used, all main coronary arteries were visibly longer, vessel sharpness was significantly better and conservation of image quality was better at longer acquisition windows.

Initial Results of Free-Breathing Balanced Fast Field Echo Whole Heart MR Angiography

David Maintz¹, Murat Ozgun¹, Andreas Hoffmeier¹, Markus Quante¹, Walter Heindel¹, Roman Fischbach¹, Warren Manning², René M. Botnar²

¹University of Muenster, Muenster, Germany; ²Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Massachusetts, USA

We successfully demonstrate the use of whole heart balanced Turbo Field Echo coronary MR angiography in healthy volunteers and patients with coronary artery disease (CAD). The technique facilitates visualization of more distal segments and side branches as well as a simplification of the scan planning procedure in comparison to targeted MRA and offers 3D reconstruction possibilities comparable to CT angiography. In patients, subjective/objective image quality and accuracy for detection of CAD was inferior to BTFE-MRA and CTA, mainly due to a lower percentage of evaluable segments.

ECG-Triggered, Free Breathing Coronary MRA Using Radial Balanced FFE With Intra-RR Motion Correction

Christian Stehning¹, Kay Nehrke², Peter Börner², Olaf Dössel²

¹University of Karlsruhe, Karlsruhe, Germany; ²Philips Research Laboratories, Hamburg, Germany

For coronary MRA, cardiac motion limits the practical acquisition window length within the cardiac cycle, resulting in a significantly prolonged scanning time. In this study, a segmented acquisition with a prolonged sampling window in diastole is investigated in this study. To cope for inter-view motion between the segments, affine motion correction was employed after image reconstruction. Finally, a high-resolution image was formed by combining the images from all segments. Scanning time was halved, while SNR was increased.
11:54  708.  An Optimized Coil Setup for Whole-Heart Coronary MRA using 2D-SENSE  
Martin Buehrer†, Michael E. Huber†, Sebastian Kozerke†, Peter Boesiger†  
†University and ETH Zuerich, Zuerich, Switzerland  
In whole-heart coronary angiography the entire heart is covered with a large non-angulated measurement volume, which allows acquiring all coronary arteries in one scan. For a further scan time reduction, the application of sensitivity encoding (2D-SENSE) in both phase-encoding directions has been suggested. The purpose of this work was to provide an optimized coil setup for 2D-SENSE and demonstrate its in-vivo feasibility. The measurements showed, that for SENSE reduction factors higher than two, the proposed setup yielded lower geometry factors on the heart and therefore enabled to achieve better image quality, when compared with the standard cardiac synergy coil.

12:06  709.  T1 Contrast Generation in Coronary MRA without the use of Contrast Agents  
Matthias Stuber†, Elmar Spuentrup‡  
†Johns Hopkins University, Baltimore, Maryland, USA; ‡RWTH Aachen, Aachen, Germany  
Natural T2 differences between blood and myocardium support an effective contrast enhancement in coronary MRA using the T2Prep. However, the natural T1 differences are too small to permit an adequate T1 contrast generation without the use of contrast agents. However, using a dual-inversion concept that incorporates a cylindrical aortic inversion pulse, endogenous bright-blood T1 contrast enhancement is feasible in coronary MRA.

12:18  710.  An Improved Magnetization Preparation Scheme for Navigator SSFP 3D Coronary MR Angiography  
Thanh D. Nguyen†, Pascal Spincemaille†, Yi Wang†  
†University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA  
In current navigator SSFP 3D coronary MRA, the navigator pulse was executed before the preparatory RF pulses. This scheme causes inaccuracy in motion detection and limits SSFP signal contrast. We investigate a new preparation scheme which minimizes the separation between the navigator and the image echoes. Preliminary data demonstrated improved motion suppression and increased vascular contrast.

10:30 - 12:30  Neuro MR Perfusion: Spin Labeling Methods  
Annex 1  
Chairs: David Alsop and Felix W. Wehrli  
10:30  711.  Time Efficient CSF Suppressed Velocity Selective ASL using a T2-FLAIR Preparation  
Eric C. Wong†  
†University of California, San Diego, La Jolla, California, USA  
In Velocity Selective ASL (VS-ASL) diffusion and flow in CSF can produce significant artifacts for Vc below approximately 3cm/s. At higher Vc, VS-ASL tagging occurs in larger arteries and does not reflect tissue perfusion. Thus for quantitative measurement of tissue perfusion, lower Vc is recommended, and CSF suppression is necessary. We introduce here a time efficient method for CSF suppressed VS-ASL using a T2-FLAIR preparation scheme. The use of T2-FLAIR is approximately 25% more time efficient than simple inversion based CSF suppression, and example VS-ASL images using this scheme are shown.

10:42  712.  To Spoil or Not to Spoil the Tagging – Arterial Transit Time Imaging in Pulsed Arterial Spin Labeling  
Jiongjiong Wang†, Gabriel S. Wetmore†, John A. Detre†  
†University of Pennsylvania, Philadelphia, Pennsylvania, USA  
A novel method is introduced for simultaneous measurements of perfusion and arterial transit time using pulsed arterial spin labeling (PASL) techniques. Based on interleaved PASL measurements with and without the saturation pulse to spoil the tagging, both quantitative blood flow and transit time information can be obtained without penalty in the signal-to-noise ratio. The results showed that the arterial transit time increases with greater distance between the imaging slice and tagging region (500-1200ms), whereas the measured tagging bolus width (~900ms) is relatively stable across space. Reduced transit time during sensorimotor stimulation was observed in both visual and motor cortex.

10:54  713.  Myocardial Perfusion by Single-Shot TrueFISP Arterial Spin Labeling  
Yi Wang†, Qun Chen†, Jian An†, Nathaniel Reichek†  
†St. Francis Hospital, Roslyn, New York, USA; ‡New York University, New York, New York, USA  
We studied the feasibility of using single-shot inversion recovery TrueFISP Arterial Spin Labeling technique to evaluate myocardial perfusion. A breath-hold mid ventricle short axis slice with both selective and non-selective pulses was imaged on 10 volunteers at rest, as well as on stress volunteer and patient. Results from the volunteer study showed uniform myocardial signal, signal change between stress and rest; signal loss on ASL image in post MI patient showed a good correlation with delayed enhancement imaging. We believe this technique provides an alternative non-contrast approach to assess perfusion reserve and detect regional myocardial perfusion.
*Matthias Guenther*, Koichi Oshio*, David A. Feinberg*

1Advanced MRI Technologies, Sebastopol, California, USA

Arterial spin labeling (ASL) can be used to measure perfusion without the use of contrast agents. A major difficulty in obtaining quantitative perfusion values is that the exact arterial transit time (ATT) needs to be known for each imaging voxel. The intrinsic low signal-to-noise ratio (SNR) of ASL makes the direct measurement of the ATT within clinically acceptable acquisition times difficult. Here, we present a single-shot 3D-GRASE sequence, which yields very high SNR due to the extended utilization of the blood signal. Up to 20 slices can be acquired at six different inflow times in less than 5 minutes.

11:18 715.  **Spatially Selective Perfusion Imaging Applying Continuous Arterial Spin Labelling**  
*Richard Werner*, Karsten Alke*, Tobias Schaeffter*, Arya Nabavi†, Olav Jansen

1Christian-Albrechts-Universität, Kiel, Germany; 2Philips Research Laboratories, Hamburg, Germany

A new method for selectively labelling left- or right-sided feeding arteries of the brain without the need for additional RF coils is demonstrated. A modified CASL sequence allows for arbitrary positioning of the labelling plane. A computer model was used to optimise key labelling parameters. The method was successfully tested in volunteers. The obtained perfusion-weighted images show a clear delineation of the perfusion territories of the selected arteries. Image contrast within the perfused area is sufficient to easily distinguish between grey and white matter.

11:30 716.  **Accuracy of Pulsed Arterial Spin Labeling in the Brain: Tag Width and Timing Effects**  

1MGH-HMS-MIT, Charlestown, Massachusetts, USA

The bolus delivery dynamics of ASL-PICORE in response to varying tag thicknesses and hypercapnia were examined. Inflow curves were generated and fit with the standard kinetic model (SKM) for ASL. Observed delivery times were less than literature values for QUIPSS2 saturation delay times, rendering the standard 10cm tag-width QUIPSS2 technique inaccurate for blood flow measurements. Hypercapnic flow changes were measured by both SKM and QUIPSS2 methodology; error between the two measurements was found to be large. A 20cm tag was demonstrated to have longer delivery times and increased perfusion sensitivity. Use of this tag would avoid error in QUIPSS2 measurements.

11:42 717.  **High Sensitivity CASL Perfusion MRI at 3T Using a 16 Channel Receiver Coil Array**  

1National Institutes of Health, Bethesda, Maryland, USA

Arterial spin labeling (ASL) perfusion MRI methods are still not widely used because of low sensitivity. This work is aimed at improving the sensitivity of ASL perfusion MRI by using a close fitting receiver coil array. We demonstrate continuous ASL perfusion MRI of the human brain at 3T using a neck labeling coil and a 16 channel receiver coil array. Results indicate that low resolution perfusion images (3X3X3 mm³) suitable for clinical applications can be obtained in ~1-2 min and higher resolution (1.5X1.5X3 mm³) images suitable for fMRI studies can be obtained in ~11 min.

11:54 718.  **Flow Territory Mapping of the Cerebral Arteries with Regional Perfusion MRI (RPI)**  
*Jeroen Hendriks*, Jeroen Van der Grond*, Hanzhang Lu*, Matthijs JP Van Osch*, Peter CM Van Zijl†, Xavier Golay†

1UMC, Utrecht, Netherlands; 2Johns Hopkins University, Baltimore, Maryland, USA

A spatially selective arterial spin labeling approach, regional perfusion imaging (RPI), is introduced which is based on selective slab inversion of the arterial water with a pulsed ASL sequence. We show the ability of RPI for selective labeling of the left internal carotid artery (ICA), right ICA and the posterior circulation (basilar artery and vertebral arteries). Furthermore, CBF values are measured in regions-of-interest within the individual perfusion territories of the selectively labeled cerebral arteries. Currently, the RPI method has been performed in 70 healthy control subjects, 20 patients with ICA occlusion and 10 patients after extracranial to intracranial bypass surgery.

12:06 719.  **Directional Dependence in Velocity Selective Arterial Spin Labeling**  
*Matt Vincent Cronin*, Eric C. Wong*, Wen-Chau Wu†, Lawrence R. Frank†

1UCSD, La Jolla, California, USA

Velocity Selective Arterial Spin Labeling (VS-ASL) is dependent upon the application of velocity encoding gradients interspersed between RF pulse elements. In previous VS-ASL studies, these gradients have been applied along a single axis. Perfusion is, however, directional and anisotropic and the significance of this in the presence of uniaxial velocity encoding gradients has not been determined. In this study, we have investigated the conditions under which the presence of off-axis flow significantly affects the perfusion image. The preliminary results of this study indicate that directional dependence in VSASL can become significant even when encoding is performed at low Vc.
White Matter Structure and Function by MR Imaging

Sakura  10:30 - 12:30  Chairs: John S. Thornton and Peter C.M. van Zijl

12:18  720.  **Simultaneous Measurements of CBV and CBF Changes using VASO-FAIR**

Xavier Golay¹, Hanzhang Lu¹, Wee Tin Hong¹, Wei-Ling Lee¹, Yih-Yian Stoh¹, Peter C.M. van Zijl²
¹National Neuroscience Institute, Singapore, Singapore; ²Johns Hopkins University, Baltimore, Maryland, USA

Quantitative BOLD imaging needs the relationship between CBF and CBV. Conventionally, Grubb’s equation is used ($\beta_{\text{CBV}} = \beta_{\text{CBF}}$ with $\alpha = 0.38, \beta = 0.8$). Here, we use a FAIR sequence to simultaneously measure CBF and CBV changes in a graded visual activation experiment in humans, in which the timing was such as to acquire all images at the blood signal nulling point to get VASO-related signal in the control acquisitions. The best fit is given by $\alpha = 0.47$ and $\beta = 0.60$, close to the recently proposed $\alpha = \beta = 0.5$, indicating that the relationship between CBV and CBF follows the basic fluid dynamics principles, considering cylindrical tubes of constant length.

10:30  721.  **Effects of Diffusion Times on Diffusions-Tensor-Imaging Contrast**

Govind Nair¹, Timothy Q. Duong¹
¹University of Massachusetts Medical School, Worcester, Massachusetts, USA

An optimized diffusion-time could potentially improve sensitivity for fiber tracking in both white and gray matters using diffusion tensor imaging (DTI). Unfortunately, longer diffusion generally requires long echo times which results in unacceptable signal loss. In this study, we implemented a DTI protocol based on Stimulated Acquisition Mode (STEAM) sequence for making long diffusion time measurements ranging from 30 to 280 ms. The effect of anisotropic index as a function of diffusion times was evaluated for gray and white matter using multispectral analysis of T2 and DTI data.

10:42  722.  **Axial and Radial Components of the Diffusion Tensor in the Myelin Mutant Shaking Pup**

Aaron S. Field¹, Yi-Jing Wu¹, Andrew L. Alexander², Yu-Chien Wu¹, Khader Hasan¹, Ian D. Duncan¹
¹University of Wisconsin, Madison, Wisconsin, USA

The microstructural specificity of quantitative MR techniques targeted to cerebral white matter remains an open question. Previous studies have suggested that the axial and radial components of the diffusion tensor might be relatively axon- and myelin-specific, respectively. We tested this hypothesis in the myelin mutant shaking pup, which is known for profound dysmyelination with relative preservation of axons, and our preliminary results were supportive. Further study is now needed to confirm these findings and then determine whether the specificities will persist in the face of such confounding factors as edema, inflammation, and gliosis.

10:54  723.  **Increased Radial Diffusivity: A Demyelination Marker**

Sheng-Kwet Song¹, Shi-Wei Sun¹, Anne H. Cross¹, Tuan Q. Le², Regina Armstrong²
¹Washington University, St. Louis, Missouri, USA; ²Uniformed Services University of the Health Sciences, Bethesda, Maryland, USA

Myelin loss and axonal damage are both observed in white matter injuries. Currently, there does not exist a non-invasive biological marker that enables differentiation between myelin and axonal injury. Cuprizone treatment is a well-established model of CNS demyelination. It is widely employed to investigate the cellular processes involved in white matter demyelination and remyelination. To validate the previously proposed DTI marker of demyelination, i.e., increased radial diffusivity, we examined the brain of cuprizone treated mice. Our results support the hypothesis that increased radial diffusivity derived from DTI analysis can be used as a demyelination marker in mouse brain white matter.

11:06  724.  **Evolving Optic Nerve Degeneration after Retinal Ischemia Assessed Using MR Diffusion Tensor Imaging**

Shu-Wei Sun¹, Won-Kyu Ju¹, Shiow-Juan Lin¹, Arthur H. Neufeld¹, Anne H. Cross¹, Sheng-Kwet Song¹
¹Washington University, St. Louis, Missouri, USA

The current study presents the extended time course of optic nerve degeneration after retinal ischemia. Serial measurements of axial and radial diffusivities from seven mice expanding 120 days after surgery are presented. In most chronic CNS injuries such as MS and stroke, the water diffusion coefficient is significantly elevated with concomitant decrease in anisotropy. This has been interpreted to reflect the tissue disintegration at the chronic stage. However, the current study demonstrates that water diffusion in optic nerve degeneration after retinal ischemia does not behave as those observed in MS or stroke.

11:18  725.  **Diffusion Tensor Imaging and Tractography of the Isolated Rat Hippocampus**

Timothy M. Shepherd¹, Evren Ozarslan², Michael A. King¹, Thomas H. Mareci¹, Stephen J. Blackband¹
¹University of Florida, Gainesville, Florida, USA

The hippocampus is a critical structure for learning and memory that is highly susceptible to injury from a wide spectrum of neurological diseases. In addition, the hippocampal structure does not represent typical gray or white matter. For these reasons, the hippocampus offers an interesting tissue substrate for diffusion tensor analysis. In this study, we report diffusion tensor measurements of the rat hippocampus at 50-mm resolution. Fractional anisotropy and mean diffusivity values for the different anatomical regions of the hippocampus appear significantly different. In addition, we report preliminary attempts to track the intrahippocampal fibers involved in the trisynaptic pathway.
Comparative 3D Anatomy of the Prosimian Brain: DTI and Histological Studies
Eric T. Ahrens1, John M. Allman2, Eliot Bush2, David H. Laidlaw3, Song Zhang3
1Carnegie Mellon University and Pittsburgh NMR Center for Biomedical Research, Pittsburgh, Pennsylvania, USA; 2California Institute of Technology, Pasadena, California, USA; 3Brown University, Providence, Rhode Island, USA

We have used computational models of white matter trajectories based on 3D DTI data to examine intact fixed brains of two rare primate species, Microcebus murinus and Daubentonia madagascariensis. Brain studies in these rare species are important because they resemble the primitive primates living millions of years ago. The isotropic 3D DTI data were acquired at ~70 micrometer resolution at 11.7 T. The 3D fiber tract trajectories were examined using streamtubes and streamsurfaces, a visual representation of linear and planar anisotropy. After imaging, histology sections were prepared in the same brains to evaluate the effectiveness of the visualization methods.

Manganese Enhanced MRI of Optic Nerve Damage and Regeneration in Rats
Marte Thuen1, Christian Brekken1, Tina Bugge Pedersen1, Axel Sandvig2, Martin Berry3, Olav Haraldseth1
1NTNU, Trondheim, Norway; 2Ullevaal University Hospital, Oslo, Norway; 3King's College, London, UK

Manganese-enhanced MRI was used to study optic nerve damage and regeneration in Fisher rats. 10 rats received varying dose of Mn2+, which gave a log-linear relationship between the dose and the contrast to noise ratio. 5 rats were injected with 100 mM Mn2+, and repetitive MRI was performed up to 168 hours. In 20 rats the optic nerve was crushed mechanically and a nerve graft was introduced into the vitreous in 10 of them. MRI performed 20 days after the crush shows higher uptake of Mn2+ in the optic nerves stimulated by nerve grafts.

Imaging the Cellular Inflammatory Response in Experimental Allergic Encephalomyelitis Using 3DFIESTA at 1.5T
Ayman Oweida1, Elizabeth Dunn1, Paula J. Foster1
1Robarts Research Institute, London, Ontario, Canada

Cellular imaging was performed using superparamagnetic iron oxide contrast agents administered i.v. in EAE rats. 3DFIESTA images show multiple discrete regions of signal void throughout the brain corresponding to iron accumulation in perivascular cuffs during inflammation.

Early In Vivo Characterisation of Relapsing Experimental Auto-Immune Encephalomyelitis Lesions by Macrophage Cellular Imaging (USPIO) Predicts Late Occurrence of Axonal Loss
Bruno Brochet1, Olivier Anne2, Tarik Touil2, Mathilde Deloire-Grassin2, Jean-Marie Caille1, Klaus Petry1, Vincent Doussset1
1Université Victor Segalen Bordeaux 2, Bordeaux, France

Macrophage infiltrates as detected in vivo by MRI with USPIO is associated with more severe acute axonal injury and are predictive for the late development of axonal loss in relapsing EAE lesions.

Differences in the Vulnerability of Gray versus White Matter to a Mild or a Moderate Hypoxic-Ischemic Insult Assessed with MR Imaging
Min Qiao1, Shuzhen Meng2, Kathryn Scobie2, Tadeusz Foniok2, Nicole Klementis1, Boguslaw Tomank2, Ursula I. Tuor3
1Institute for Biodiagnostics (West), Calgary, Alberta, Canada; 2University of Calgary, Calgary, Alberta, Canada

Premature infants are susceptible to cerebral white matter damage – an injury that has been difficult to mimic in rodent models. A rather selective white matter injury in neonatal rats was produced by reducing body temperature and duration of hypoxia compared to the more severe widespread injury observed in both gray and white matter in the usual 7 day old rat model of cerebral hypoxia-ischemia. These differences were apparent in T1 and T2 maps used to assess injury at 24 hours post HI. Thus, selective white matter injury can be induced by a mild hypoxic-ischemic insult in immature brain.

fMRI of Complex Neural Systems

Evidence of a Topological Map of the Environment in the Left Inferior Parietal Lobule
Peter Brotnich2, Shoane Ip2, Graeme Jackson2
1Brain Sciences Institute, Melbourne, Victoria, Australia; 2Brain Research Institute, Melbourne, Victoria, Australia

To understand the neural mechanisms underlying spatial navigation it is necessary to determine the underlying computational processes. Computational models of navigation can be divided into those which generate topological maps of the environment and those which use map-less navigation. Since a topological map of space has never been discovered in the human brain, both map based and map-less models are biologically plausible. In this study we examine the effects caused by perturbations in 10 subjects’ perceived spatial location within a 3D virtual environment. Functional activation within the left inferior parietal lobule suggests the presence of a cognitive spatial map.
**Friday AM**

10:42 732. **An fMRI Study of Self and Other Perspectives in the Observation and Imagination of Actions.**
David Kingsley¹, Arshad Zaman², Neil Roberts¹
¹University of Liverpool, Liverpool, UK

Actions performed by self, observed in others, or imagined share neural representations. However, self-performed actions are distinguished from those generated by others. Evidence suggests that parietal activity may mediate internal “perception” of sensory consequences of actions, allowing distinction between self and other. This study explored agency in relation to action observation and imagination by creating tasks in both modalities from self and other perspectives. Parietal activity for self-imagination was left-sided, whereas for other-imagination it was more right-sided. Other differences in laterality were found suggesting self-other perspective is a lateralised function in several neural areas for both imagination and observation.

10:54 733. **Brain-Computer-Interface using fMRI: Spatial Navigation by Thoughts**
Seung-Schik Yoo¹, Ty Fairneny², Nan-Kuei Chen¹, Lawrence P. Panych¹, Hyun-Wook Park¹, Soo-Young Lee³, Ferenc A. Jolesz⁴
¹Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; ²Boston University, Boston, Massachusetts, USA; ³KAIST, Daejeon, Republic of Korea

We developed an fMRI method, capable of characterizing specific regional brain activity in real-time and used it as an interface between the brain function and a computer control, enabling Brain-Computer-Interface (BCI). The method, implemented in a 3T MRI system, was designed to detect different spatial patterns of brain activities generated from four functional tasks (all covert or imagery) performed by the subjects. Each task was then interpreted as predetermined computer commands to move the cursor for spatial navigation. Although preliminary, our data suggest the technique successfully interpreted the intention of the users with greater than 92% accuracy.

11:06 734. **An fMRI Study of Two Types of Tool-Use Gestures: Body-Parts-As-Object and Pantomime**
Y. Ohgami¹, K. Matsuo¹, K. Toma¹, K. Oishi², N. Uchida³, T. Nakai³
¹National Institute of Advanced Industrial Science and Technology, Ikeda,Osaka, Japan; ²Institute of Biomedical Research and Innovation, Hyogo, Japan; ³Kobe University, Kobe,Hyogo, Japan; ⁴Ochanomizu University, Bunkyo-ku,Tokyo, Japan

Body-parts-as-object gesture (BPO) is one of the error patterns in apraxia. In BPO, people represent objects by hand shapes or movements. To clarify the neuronal background of the BPO, we compared brain activation during the BPO with that during the pantomime gestures (MIME) using fMRI in normal subjects. Both BPO and MIME induced activation in the left parietal lobe, which is related to tool concepts. BPO also activated the right inferior parietal lobule, which is involved in visuospatial perception and manipulations. This suggested that this area supported the transformation processes of the body parts into the object images during BPO.

11:18 735. **Neural Correlates of the Cueing Effect of Another Person’s Gaze Studied with fMRI**
Chikako Kato¹, Kayako Matsuo¹, Toshiharu Nakai²
¹Toyohashi Sozo College, Toyohashi, Aichi, Japan; ²AIST, Ikeda, Osaka, Japan

Visual target detection is faster at the location predicted by a cue, even if the cue is totally uninformative. We investigated this cueing effect of eye gaze in comparison with the other central cue, an arrow, using fMRI. We used the cue-target stimulus onset asynchrony (SOA) of 100 and 500 msec. The left precentral and intraparietal sulci were activated only in the experiment using a pattern of eyes at 500-msec SOA. This front-parietal activation may be corresponding to the difference of the time course of the cueing effects between eye gaze and the arrow.

11:30 736. **Visualizing Anterior Temporal Activation during Semantic Processing with Parallel Imaging Techniques**
Ronald Roel Peeters¹, Mathieu Vandenberghe¹, Rik Vandenberghe¹, Paul Van Hecke¹
¹Katholieke Universiteit Leuven, Leuven, Belgium

fMRI has become the standard tool for the visualization of brain activation during various cognitive tasks. The advent of parallel imaging techniques makes it possible to perform cognitive fMRI studies in those areas which previously suffered from susceptibility artifacts. This study demonstrated the ability of the fMRI technique using parallel imaging techniques to replicate a previous PET study and to find activation in the anterior temporal lobes of the brain.

11:42 737. **New Methods for Determining the Dominant Hemisphere in Language fMRI: A Reproducibility Study**
David Brennan¹, Celestine Santosh¹, Barrie Condon¹, Donald Hadley¹
¹Southern General Hospital, Glasgow, UK

This study aims to further enhance the ability of fMRI to determine the dominant cerebral hemisphere in language studies. It investigates the effects of combining laterality scores from two separate language paradigms on the reproducibility of the technique at two separate imaging sessions two weeks apart. Information from the two paradigms is used to produce two new indices; the mean laterality index and the mean z-score statistic. The reproducibility of the new indices are determined with further conclusions on their use in future studies.
Friday AM

11:54  738. **Speech Perception and Speech Production Systems Overlap in Posterior Auditory Cortex: An fMRI Study**  
Kayoko Okada¹, Gregory Hickok¹  
¹University of California, Irvine, California, USA

The present 4T functional MRI study investigated the role of posterior auditory cortex in speech perception and production and we examined whether input and output systems share a common neural substrate. Healthy adult volunteers participated in a passive listening task and a covert object naming task. Single subject analysis revealed overlapping sites in posterior superior temporal lobe. Specifically, Area Spt (Sylvian-Parietal-Temporal), activated in all 10 subjects during perception and production of words. Results suggest that speech input and output systems overlap in posterior auditory cortex and provide support for the proposal that Area Spt is involved in auditory-motor transformation function.

12:06  739. **Real-Time Assessment of Explicit Motor Sequence Learning by Functional MRI**  
Kenichi Oishi¹, Epifanio Bagarinao², Keitchoiro Tomata³, Kayako Matsu³, Toshiharu Nakai³, Kazuo Chihara¹, Hidenao Fukuyma³  
¹Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan; ²National Institute of Advanced Industrial Science and Technology Kansai Center, Ikeda, Osaka, Japan; ³Kyoto University Graduate School of Medicine, Kyoto, Japan

The aim of this study was to assess the usefulness of real-time fMRI analysis in evaluating explicit motor sequence learning function. Brain activation during Serial Reaction-Time Task (SRTT) was obtained from sixteen normal subjects. Signal intensity change (∆SI) in the precuneus was related to the relative shortening of the reaction time during SRTT. Our data suggested that the measurement of ∆SI in the precuneus is important in the evaluation of explicit motor sequence learning function, and that the real-time analysis of fMRI was excellent in extracting the results immediately after the scan, which is important for fMRI clinical applications.

12:18  740. **Medial Temporal Lobe Activation in Episodic vs. Familiarity-Based Memory Retrieval**  
Martin Zalesak¹, Anthony P. Weiss², Ian Dewitt², Tali Ditman², Stephan Heckers²  
¹Massachusetts Institute of Technology, Cambridge, Massachusetts, USA; ²Massachusetts General Hospital, Charlestown, Massachusetts, USA

We investigated the role of medial temporal lobe (MTL) in declarative memory retrieval. Previous functional neuroimaging studies employing whole-brain voxel-based analyses led to the hypothesis that the hippocampus selectively supports retrieval of events (episodic memory retrieval) while surrounding MTL structures support conscious recognition of previously encountered items (familiarity-based memory retrieval). We applied a novel anatomically guided region-of-interest (ROI) analysis of episodic and familiarity-based memory retrieval to show that the hippocampus does not play a unique role in, and that various MTL structures (i.e., amygdala, hippocampus, and cortical areas, including entorhinal, perirhinal and parahippocampal cortex) contribute to, episodic memory retrieval.

Advances in Gradient Coil Design and Field Homogeneity Improvement

Room D  10:30 - 12:30  Chairs: Labros S. Petropoulos and Gary Shen

10:30  741. **Construction of a 5000 G/cm Z-Gradient Coil for q-Space Microscopy**  
A. C. Wright¹, H. Bataille¹, S. L. Wehrli², C.-L. Chin³, F. W. Wehrli³  
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA; ²Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA

Q-space imaging has potential to provide detailed quantitative information on the geometry of structures at cellular resolution. However, the size of restrictions that can be probed hinges on available gradient amplitude and places very high demands on gradient performance. In this work, we constructed a relatively low-cost, high-amplitude (5000 G/cm) quadrupolar z-gradient coil, and combined it with the x- and y-gradients of a commercial 9.4 T microimaging system. Preliminary q-space microscopy experiments on 4.5 µm diameter polystyrene microspheres showed the expected q-space diffraction peak.

10:42  742. **Updating of MRI Gradients Using a Infrared Tracking System to Compensate Motion Artifacts**  
Christian Dold¹, Maxim Zaitsev², Oliver Speck², Evelyn Angela Firle¹, Juergen Hennig², Georgios Sakas¹  
¹Fraunhofer Institute, Darmstadt, Germany; ²University Hospital Freiburg, Freiburg, Germany

We aim to provide a next generation magnetic resonance imaging (MRT) system technology with an integrated solution for reducing motion artifacts in brain imaging applications. The coordinate system of the MRI scanner is overlapped with the coordinates from an infrared motion tracking system (IMTS) using retro reflective markers. The coordinate system of the MRI scanner will follow the tracked head motion received from the (IMTS). The resultant time delay of the whole measurement chain is described in detail. The MRI compatibility of the IMTS and finally its accuracy in rotation and translation are measured in a custom build phantom.
We introduce a novel multi-layer gradient design based on decomposing the desired magnetic field profile into spatial harmonics, then representing each low order harmonic by a separate wire layer. If the multiple wire layers that form a single gradient axis are driven with arbitrary and user-selectable currents, the result is an unprecedented flexibility in the strength/linearity trade-off. Furthermore, this harmonic gradient design permits a new capability to optimize gradient performance within the limits imposed by gradient induced peripheral nerve stimulation.

A current distribution on the surface of a hemisphere may be represented as an infinite sum of full spherical harmonics. We have derived expressions for the magnetic field and stored energy of such a current distribution, which allow the design of minimum inductance, hemispherical gradient coils. The resulting designs are well suited to use as insert head gradient coils, and have superior performance to their cylindrical counterparts. Axial and transverse hemispherical designs (in the latter case, including torque balancing) have been produced and a small prototype axial coil has been fabricated and tested to validate the design method.

The harmonic gradient coil for the eight-channel parallel MR microscope was developed and imaging experiments were performed. The obtained eight individual images demonstrated that the system had a sufficient performance for large number of parallel mice imaging.

High speed switching of current in gradient coils within high magnetic field strength MRI scanners may result in high acoustic sound pressure levels. Based on a validated FE model, an acoustic noise analysis model was developed to characterize the noise behavior of the gradient coil. Acoustic noise measurement in a 4T MRI under swept sinusoidal excitation shows that the acoustic model predicted the noise properties accurately. Two types of trapezoidal sequences were used to verify the new acoustic model. Very close agreement was obtained between the predictions of the acoustic model and the experimental noise measurements.

An important source of MRI acoustic noise--magnet cryostat warm bore vibrations caused by eddy-current-induced forces--can be mitigated by a passive metal shield on the outside of a vibration-isolated, vacuum-enclosed shielded gradient set. Finite element calculations for a z-gradient indicate that a 2 mm thick Cu layer wrapped on the gradient assembly would decrease energy deposition in the warm bore and reduce warm bore acoustic noise production by 25 dB. Eliminating the warm bore and other magnet parts as significant acoustic noise sources could lead to truly quiet, fully functioning MRI systems with noise levels below 70 dB.

Dynamic Shim Updating (DSU) is a mechanism for globally compensating susceptibility-induced inhomogeneities. Here, we present the application of DSU using first and second order spherical harmonic shims on the human brain. DSU allows one to set optimal shim values for each slice within a multi-slice volume acquisition. The key benefit of this technique is the ability to compensate out locally manageable inhomogeneities in a global fashion. Significant in-vivo homogeneity differences within the human brain were observed when comparing global and multi-slice shim settings. The methods and results of these investigations are presented.
12:06 749. **Design of an Optimized Open-Access Human-Scale MRI Magnet for Orientational Lung Study**  
Matthew S. Rosen1, Leo L. Tsai2, Ross W. Mair3, Ronald L. Walsworth4  
1Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA; 2Harvard-MIT Division of Health Sciences and Technology, Cambridge, Massachusetts, USA

Laser-polarized 3He MRI provides a powerful method to study lung function and inhalation, but in traditional MRI systems subjects are restricted to lying horizontally. We have employed a novel bi-planar B0 coil design and planar gradients to create a second-generation optimized open-access human imager with B0 up to 100 gauss and better than 50 ppm homogeneity over a 40 cm DSV for 3He MRI.

12:18 750. **‘Homogeneity Helmet’ for Correcting Susceptibility Artifacts in fMRI**  
Arnon Neufeld1, Yaniv Assaf2, Gil Navon1  
1Tel Aviv University, Tel Aviv, Israel; 2Tel Aviv Sourasky Medical Center, Tel Aviv, Israel

B0 inhomogeneity is a source of signal loss and severe artifacts in f-MRI which is based on fast GE-EPI sequences, especially in high (≥3T) fields. We suggest constructing a ‘helmet’ that surrounds patient’s head, which should shift the boundary effects of B0 away from the head. We have demonstrated the correction effect on a water phantom with an air cavity that was surrounded by a layer of Fluorinert. Results show a dramatic effect of artifacts correction in EPI under conditions commonly used for BOLD imaging, and a major improvement in the total SNR of images due to longer T2*.

**Image Processing: Segmentation, Registration, Other**

Room B-1  10:30 - 12:30  Chairs: Dennis L. Parker and Michael H. Buonocore

10:30 751. **Methodology for the Histopathologic Correlation with Functional MR Images of the Prostate by Successive Morphing**  
Stefan A. Reinsberg1, Liz M. Moore1, Aslam Sohail, Cyril Fisher, Andrew Jackson, David Dearnaley1, Martin O. Leach1  
1Institute of Cancer Research & Royal Marsden NHS Trust, Sutton, UK

Improvements in the treatment of prostate cancer has made the identification of highly sensitive and specific non-invasive MR tumour markers a clinical priority. Comparison of non-invasive MR parameters with histopathologic evaluation of tissue samples has faced significant practical difficulties. Problems with this process include uncertainties arising from distortions in images, specimen deformation in the process of slicing and the ability to register MR images to histopathologic slices. The presented methodology of successively morphing photographs of stained sections to fresh tissue slices and MR images reduces these uncertainties to a minimum and allows a pixel-by-pixel correlation.

10:42 752. **Breast Tumor Segmentation and Characterization Using Dynamic Contrast-Enhanced MR Images for Computer Aided Diagnosis**  
Rashmi Raghavan Parakkal1, Zhiyu Liu1, Min Luo1, Beth Burnside1, Frederick Kelcz1, Jiang Du1, Sean Fain1  
1University of Wisconsin - Madison, Madison, Wisconsin, USA

The proposed CAD technique has shown promising results for distinguishing malignant and benign tumors in the breast based on the contrast dynamics of tumor uptake and washout. The combination of DCE breast MRI, automated segmentation and multi compartmental modeling was applied to 6 patients with 8 lesions of known pathology. The CAD correctly classified all lesions in this small patient population. Larger studies are ongoing.

10:54 753. **A Methodology for Anatomical 3D Modelling of Patients’ Bones from MRI**  
Benjamin Gilles1, Rosalind Perrin1, Jean-Paul Vallée1, Laurent Moccozet1, Nadia Magnenet-Thalmann1, François Terrier2  
1University of Geneva, Geneva, Switzerland; 2Geneva University Hospital, Geneva, Switzerland

This paper presents a methodology for anatomical modelling of human bones from MRI for both surgical preoperative planning and post surgical guides. Bone-specific 3D acquisition protocols are defined. Generic models are reconstructed and then used as discrete deformable models to reconstruct any individual models automatically. The method is based on a multi-resolution energy optimisation. Results are given, for the hip joint, in terms of accuracy, computational speed and robustness. The long term goal of this work is to provide anatomical models for the functional modelling of the lower limb.

11:06 754. **Edge Detection at Low Resolution using Padé Approximants**  
Martina F. Callaghan1, David J. Larkman1, Michael C K Wiltshire1, Jo V. Hajnal1  
1Hammersmith Hospital, Imperial College London, London, UK

Extraction of salient structures in MR images often relies on thresholds or direct edge detection both of which benefit from high-resolution data for accuracy and reliability. In conventional MRI, acquiring higher resolution data increases the scan time, reducing the achievable temporal resolution and increasing the risk of motion artefact. Here we present a method for automatic edge detection based on Padé approximants, using reduced resolution data. This method was tested using high-resolution cardiac images and phantom data progressively truncating their k-space data sets. The degree of truncation achievable whilst maintaining accurate edge detection depends on the structures being imaged.
11:18 755. **Automatic Cerebellum Skeleton Extraction in Human MR Brain Images**

*Jing Z. Liu, Lu D. Zhang, Guang H. Yue*

*Cleveland Clinic Foundation, Cleveland, Ohio, USA*

Image skeletons have been widely used in recognition and representation of objects, and analysis of medical data. In this project we developed an automatic algorithm for extraction of the white matter skeleton of human cerebellum (CB) from MR images based on the ordered region growing (ORG) method and scale-space theory. The method can yield accurate 2D and 3D CB skeletons, which may be used to study CB morphological changes due to white matter diseases.

11:30 756. **Stair-Stepped Removal via Automatic Linearization for Marching Cubes Formulations**

*Wei Huang, John M. Sullivan, Jr., Reinhold Ludwig, Praveen Kulkarni, James Q. Zhang, Jean A. King*

*Worcester Polytechnic Institute, Worcester, Massachusetts, USA; University of Massachusetts, Worcester, Massachusetts, USA*

The Marching Cubes algorithm is one of the most widely adopted methods for reconstructing surfaces from medical images. However, this routine creates significant stair-stepped geometry artifacts due to the interpolation mechanism within each individual cube. Numerous post-processing smoothing efforts have been and are being made but they either cause volume shrinkage, geometry alterations or are computationally expensive. Herein, a linearization algorithm is presented that completely eliminates the stair-stepped outcome for marching cube routines. This process increases the accuracy of the model by an order of magnitude while preserving the volume and geometry integrity.

11:42 757. **Flow Dynamics in an In Vitro Aneurysm Model at 1.5 and 3.0 Tesla**

*John W. Grinstead, Shantanu Sinha, Satoshi Tateshima, Yih-Lin Nien, Fernando Vinuela*

*University of California, Los Angeles, Los Angeles, California, USA*

A robust, multi-platform, and extensible software package was developed in Matlab to process multi-directional phase contrast flow quantification images. It was applied to images of an in vitro basilar tip aneurysm model taken at 1.5 and 3 Tesla. The software allowed the visualization of complex intra-aneurysmal flow structures by the use of contour maps, vector field plots, particle tracking, and cine animations. The goal of this work is to develop more routine and readily available methods to quantify complex blood flow dynamics.

11:54 758. **Parcellation of Cerebral Cortex based on FLAIR Signal Intensity**

*John Anthony Butman, Andrea J. Rebmann*

*National Institutes of Health, Bethesda, Maryland, USA*

Parcellation of the cerebral cortex based on cytoarchitectonic and myeloarchitectonic features defines multiple distinct anatomic regions such as the well known Brodmann areas. FLAIR signal intensity demonstrates several levels of signal intensity which, when mapped onto cortical surfaces, shows striking concordance to known regional cortical differences. FLAIR signal intensity variation across the cortex forms a basis for parcellating the cortex architecturally into several distinct areas.

12:06 759. **PD, T1, and T2 Quantitative MRI Spectroscopy of the Orbit: an Application of the Mix-TSE Pulse Sequence**

*Hernan Jara, Keith Fleming, Osamu Sakai*

*Boston University Medical Center, Boston, Massachusetts, USA*

Purpose: To develop a structural MRI technique for the assessment and quantitative characterization of the main structures and tissue types in the human orbit. Methods: Structural segmentation was accomplished by interrogating every pixel as to whether it is contained in a certain PD, T1, T2 Q-MRI space volume and also as to whether it was clustered with other Q-MRI-similar pixels in direct image space. Conclusion: A technique for resolving into structural segments and characterizing by Q-MRI spectroscopy the main components of the human orbit has been developed. The technique is semi-automated requiring only a few numerical inputs from the user.

12:18 760. **Unbiased Nonlinear Filtering of Fast Spin Echo MRI Images**

*Alexei Samsonov, Chris Johnson*

*University of Utah, Salt Lake City, Utah, USA*

Intensity bias in magnitude MRI images arises due to the Rician properties of noise in the images. Denoising using a spatial averaging technique makes the bias even more evident. We present a nonlinear filtering scheme for spin-echo MRI images that fulfills structure-preserving image denoising and at the same time eliminates the bias. The method fulfills spatial averaging separately on each channel of complex image, while obtaining the image structure information from its magnitude part. The separate filtering is possible due to the phase smoothness property of spin echo images. The method was demonstrated with phantom and patient data.
Applications of Hyperpolarized Gases

Room B-2  10:30 - 12:30  Chairs: Klaus K. Gast and Brian T. Saam

10:30  761.  Assessment of Cystic Fibrosis in Children using Hyperpolarized 3-Helium MRI: Comparison with Shwachman Score, Chrispin-Norman Score and Spirometry.
   Edwin J. van Beek1, Catherine Hill1, Neil Woodhouse1, Stanislao Fichele1, Sally Fleming1,
   Barbara Howe1, Sandra Bott1, Christopher J. Taylor1, Jim M. Wild1
   1University of Sheffield, Sheffield, South Yorkshire, UK

This pilot study assessed the potential use of hyperpolarized 3-He MRI in children with cystic fibrosis. The MRI scores were compared with traditional clinical parameters, such as spirometry, Chrispin-Norman score and Shwachmann score. 3-He MRI was more closely correlated with lung function than the traditional scores used in clinical management. 3-He MRI appears a superior diagnostic test in the assessment of CF severity, and may have an impact on management of these patients.

10:42  762.  Stimulated Echoes Hyperpolarized Helium-3 Imaging: Application to Lung Perfusion Imaging
   Vasile Stupar1, Yves Berthezène2, Emmanuelle Canet2, David Dupaich1, Philippe Anfré2, Hervé Tournier2, Yannick Crémillieux2
   1CNRS 5012, UCBL - CPE, Lyon, France; 2CNRS 5515, Hôpital Cardiologique, Lyon, France; 3Bracco Research, Geneva, Switzerland

Ventilation images using hyperpolarized helium3 and intravascular superparamagnetic contrast agents injection were performed with a new STEAM-based imaging sequence. The proposed imaging protocol proved to be very sensitive to the presence of contrast agent into the lung vasculature and allowed the acquisition of lung perfusion-weighted images.

10:54  763.  Human Imaging of Ventilation-Perfusion Ratios Using Hyperpolarized Helium-3 MRI: Preliminary Results
   David Lipson1, Martin C. Fischer1, Warren Gefter1, John Hansen-Flaschen1, Jiangsheng Yu1,
   Zehulon Z. Spector1, Sheeva Rajaei1, Kiarash Emami1, David Neujahr1, Thomas Connick1, Michelle Law1, Masaru Ishii2, Mitchell Schnall1, Rahim R. Rizi1
   1University of Pennsylvania, Philadelphia, Pennsylvania, USA; 2Johns Hopkins University, Baltimore, Maryland, USA

Using non-invasive, hyperpolarized helium-3 MRI techniques we successfully determine regional alveolar oxygen concentrations, and then calculate and map the regional ventilation to perfusion ratios in humans. In this abstract we describe the technical feasibility of calculating regional ventilation to perfusion ratios in normal human subjects. The calculations involve a variation of established gas-exchange equations.

11:06  764.  Assessment of Lung Ventilation, Gas Trapping and Pulmonary Perfusion in Patients with Asthma during Inhaled Corticosteroid Withdrawal
   Shilpa Ravishankar Panth1, Sean B. Fain1, James H. Holmes1, Sandra C. Fuller1, Frank R. Korosec1,
   Thomas M. Griss1
   1University of Wisconsin-Madison, Madison, Wisconsin, USA

Assessment of pulmonary function in volunteers with asthma was performed before and after a cortico-steroid withdrawl (ICS) paradigm using helium-3 (3He) MRI (breath-hold and dynamic) and perfusion MRI. Preliminary results demonstrate peripheral ventilation abnormalities at baseline and during exacerbation, and regional gas trapping following ICS withdrawal. Corresponding perfusion MRI has thus far been found to be normal in regions of ventilation anomalies.

11:18  765.  Assessment of Lung Development using Hyperpolarized Helium-3 Diffusion MR Imaging
   Talissa Ann Altes1, John P. Mugler, III1, Jaime Mata1, Jennifer Benjamin-Watkins1, Summer R. Herlihy1, Eduard E. de Lange1, James R. Brookeman1
   1University of Virginia, Charlottesville, Virginia, USA

It is widely believed that humans grow new alveoli from a few weeks before term birth until approximately 8 years of age. After 8 years of age, the alveoli are thought to enlarge as the lungs increase in volume but no new alveoli are formed. The purpose of this study was to determine whether this normal age-related change in lung structure can be detected with hyperpolarized He-3 diffusion MR imaging. We found that the mean ADC increases with age in the pediatric population and that the mean ADC is lower in the pediatric age group than in young adults.
11:30 766. Magnetic Susceptibility Matching at the Air Tissue Interface in Rat Lung using Hyperpolarized Gas and Super Paramagnetic Contrast Agent
Alexandre Vignaud1, Geneviève Guillot1, Luc Darrasse1, Xavier Maitre1, Emmanuel Durand1, Ludovic de Rochefort1, Philippe Robert2, Véronique Vivès3, Robin Santus3
1CNRS UMR8081, Orsay, France; 2Guerbet Research, Aulnay-sous-bois, France

The contribution of magnetic susceptibility difference between air and tissue to transverse relaxation of hyperpolarized helium-3 in lungs is a key issue for MRI strategies. The susceptibility of air is close to the one of oxygen. Tissue susceptibility depends on both the parenchyma and the blood susceptibilities, both of them being close to water susceptibility. In this work, intravenous injections of superparamagnetic contrast agent were performed in rats to modify their blood susceptibility, so as to match the magnetic susceptibility of pulmonary tissue to that of air. First results and perspectives of improvement for MRI are presented.

11:42 767. Time- and Spatially-Resolved In Vivo Human Brain MR-Spectroscopy using Hyperpolarized 129Xe
Wolfgang Kilian1, Frank Seifert1, Herbert Rinneberg1
1Physikalisch-Technische Bundesanstalt, Berlin, Germany

A commercially available double resonant 1H/129Xe open birdcage head-coil with a uniform B1-field distribution over the human brain was used for time-and spatially-resolved in vivo 129Xe MR spectroscopy. To analyze the time course of signal amplitudes an existing brain perfusion model was extended to account for long inhalation times (tinhale>10s). For 2D-CSI measurements we implemented a spiral-like sampling of k-space yielding signals restricted to the brain region. For the first time signals from both 129Xe-lines (@ 196 ppm and 193 ppm) were resolved in 2D-CSI images.

11:54 768. Functional Brain Imaging Using Hyperpolarized 129Xe
Mary L. Mazzanti1, Yanping Sun1, Joey Mansour1, Niral Shah1, Sameer S. Doshi1, Ferenc Jolesz1, Mitchell S. Albert1
1Brigham and Women’s Hospital, Harvard Medical School, Boston, Massachusetts, USA

In this study we demonstrate, for the first time, the use of hyperpolarized xenon (HP 129Xe) MRI as a method for functional imaging in the brain. Adult male Sprague-Dawley rats were ventilated with HP 129Xe and oxygen. A baseline HP 129Xe chemical shift image (CSI) revealed unrestricted distribution of 129Xe throughout the brain. Functional brain haemodynamic changes evoked by the administration of CO2 could be clearly detected by HP 129Xe in the rat brain. Because HP 129Xe is sensitive to both blood flow and O2 content, it is uniquely suited for further development as an indicator of functional brain activity.

12:06 769. The Apparent Diffusion Coefficient of Xe-129 in the Lung: Preliminary Human Results
John P. Mugler, III1, Jaime F. Mata1, Hsuan-Tsung J. Wang1, W. Alexander Tobias2, Gordon D. Cates2, John M. Christopher2, Jayne L. Missel2, Andre G. Reish2, Kai Ruppert2, James R. Brookeman2, Klaus D. Hagspiel2
1University of Virginia, Charlottesville, Virginia, USA; 2Advanced MRI Technologies, Sebastopol, California, USA

Recent improvements in the polarization levels for liter quantities of Xe-129 have made it practical to perform Xe-129 diffusion imaging in the human lung with spatial resolution similar to that achieved with He-3. Compared to He-3, the length scales probed by Xe-129 are expected to be smaller, and perhaps diffusion imaging with Xe-129 can provide unique information regarding disease-induced structural changes in the lung. We report here preliminary measurements of the Xe-129 ADC in the healthy human lung. The ADC values in two healthy subjects were 5-6 times smaller than those typically measured by using He-3.

12:18 770. Comparison of 129Xe Spectra from Intact and ECA/PPA Obstructed Rat Head
Yasushi Kondoh1, Atsushi Waka2, Kazuhiro Nakamura2, Jeff Kershaw2, David Wright2, Iwao Kanno1
1Akita Research Institute for Brain and Blood Vessels, Akita-shi, Japan; 2Akita Industry Promotion Foundation (AIPF), Akita-shi, Japan

It is shown by ligating the major feeding vessels of non-brain head tissue in rat that only a single predominant peak can be attributed to brain.
Muscle Imaging

Room E  Monday 14:00 - 16:00

14:00  771. Effects of Cessation and Treatment of Risedronate on Multiple Skeletal Implications of Corticosteroid Exposure
Masaya Takahashi¹, Felix W. Wehrli²
¹Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, Massachusetts, USA; ²University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA

The effects of antiresorptive on the skeletal implications of corticosteroid exposure were evaluated longitudinally by micro MRI and spectroscopy in young rabbits. Corticosteroid exposure resulted in a significant reduction in trabecular bone volume fraction (BVF), a conversion of hematopoietic to yellow marrow and atrophy of the femoral epiphyseal growth plate. Whereas BVF was found to recover completely after cessation of corticosteroid exposure or as the result of bisphosphonate treatment, the other skeletal alterations were irreversible. The findings might have implications on high-dose steroid treatment of the pediatric population.

14:01  772. NMR Study of the Dynamic Properties of Bone Water
Robert Christopher Wilson¹, Maria A. Fernandez-Seara², Felix W. Wehrli¹
¹University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA; ²Institute of Neurology, University College, London, UK

Water plays a pivotal role in bone, but its nature and binding states are poorly understood. Two of these binding states have previously been distinguished by NMR. In this work we measured the FID from cortical bone as a function of time while drying in air at 100 C for 48 hours. Unexpectedly, water loss from all binding states occurs in two stages with a sharp transition between the two at 6 hours. The decay in each stage is approximately mono-exponential allowing calculation of diffusion coefficients which are found to be an order of magnitude smaller in the second stage.

14:02  773. The Heterogeneity of Intramuscular Metabolism using Simultaneous 31P 2D-CSI and Pulmonary Oxygen Uptake (VO2) during Incremental Knee-Extensor Exercise in Humans
Harry B. Rossiter², Brian J. Whipp³, Susan A. Ward³, Dominick J O McIntyre², John R. Griffiths³, Franklyn A. Howe³
¹University of California, San Diego, La Jolla, California, USA; ²Harbor-UCLA Medical Center, Los Angeles, California, USA; ³University of Leeds, Leeds, UK; ⁴St. George's Hospital Medical School, London, UK

In order to better understand the mechanisms determining exercise intolerance at the limit of ramp-incremental exercise, pulmonary O2 uptake (VO2) was determined in conjunction with 31P 2D-CSI during quadriceps exercise. While 'global' metabolic responses to ramp exercise were functionally linear, the proportional contributions from different quadriceps muscles were highly variable (at end-exercise, metabolite concentrations ranged from −50% to +70% of the mean) and peak VO2 was reached with an intramuscular energy-store remaining. These data suggest that the exercise intolerance resulted from regional and limiting build-up of fatigue-inducing metabolites, within only some 15% or less of the recruited muscle mass.

14:03  774. Combined Diffusion and Perfusion MRI in Evaluating Skeletal Ischemia
Nina M. Menezes¹, Elizabeth A. Olear¹, Rafael M. Jimenez¹, Susan A. Connolly³, Frederic Shapiro², Diego Jaramillo¹
¹Massachusetts General Hospital, Boston, Massachusetts, USA; ²Children's Hospital, Boston, Massachusetts, USA

Ischemia of growing cartilage and bone is a common cause of childhood disability. Ischemia can be visualized via perfusion MRI. However, lack of blood flow alone does not indicate the severity of the damage, which has implications for prognosis and planning therapy. We combined perfusion measurements with diffusion MRI to study ischemia in an animal model and have found that diffusion changes follow a different time course than perfusion. Diffusion increases in early ischemia and remains elevated despite flow restoration, suggesting that it may uniquely indicate irreversible damage.

14:04  775. Calculation of Muscle Fiber Orientation and Length in the Human Soleus by Diffusion Tensor Imaging
Craig J. Galban¹, Stefan Maderwald², Armin de Greiff³, Kai Uffmann¹, Mark E. Ladd³
¹University Hospital of Essen, Essen, Germany

It has recently been shown that muscle fiber length and orientation can be measured using diffusion tensor magnetic resonance imaging. We hypothesize that this technique can be applied to human subjects using clinical systems, and that changes in fiber length and orientation during muscle contraction can be obtained. We measured the fiber length, pennation angle, eigenvalues and fractional anisotropy in the human soleus during rest and contraction. Our results demonstrate that DT-MRI is a sensitive method for non-invasively measuring muscle fiber architecture.
The Use of MRI to Monitor Blood Flow and Oxygenation Changes Accompanying Hyperaemia in Human Foot Muscle
Caroline Hoad, Penelope Gowland, Ian Macdonald, Richard Donnelly, Susan Francis
University of Nottingham, Nottingham, UK

Vascular changes in the foot are of particular importance in diseases such as Diabetes and Peripheral Arterial Disease. This study evaluated an ASL technique to monitor the hyperaemic response of skeletal foot tissue following 2-minute and 5-minute ankle arterial occlusions (AOs), by measuring the parameters M0 (related to perfusion) and T2* (related to oxygenation and blood volume). Time to hyperaemic peak was increased from the 2-minute to 5-minute AO with the T2* peak delayed compared to the M0 peak. This study showed the feasibility of using ASL MRI to monitor hyperaemia in skeletal foot tissue.

Study of the Contribution of Oxygenation to the BOLD Contrast in a Moderate Exercise Protocol of the Mouse Gastrocnemius Muscle
Bénédicte Jordan, Bernard Gallez
Catholic University of Louvain, Brussels, Belgium

This study documents that increases in the BOLD signal intensity can be observed in mouse skeletal muscle performing a moderate and prolonged (15 minutes) exercise protocol. We demonstrated that the BOLD response is likely to depend on oxygenation and blood flow effects at the onset of exercise, and on the single effect of oxygenation after resumption of electrical stimulation. Blood flow and T2 changes are indeed not correlated with the maintain in the BOLD signal intensity after exercise, on the contrary to muscle pO2.

A Model for the Muscle Functional MRI Signal Intensity Time Course
Bruce M. Damon, John C. Gore
Vanderbilt University, Nashville, Tennessee, USA

Muscle functional MRI (mfMRI) reflects the metabolic and hemodynamic responses of muscles to exercise, but the relative importance of these factors to the mfMRI signal intensity time course is unknown. To test this, a computer model of the human neuromuscular system was developed, including reasonable assumptions about the time course of metabolic and hemodynamic events as well as their impact on MR relaxation rates. The model replicated the mfMRI time course well and was used to predict that the relative importance of blood oxygenation is greatest at early exercise durations, while metabolic changes are most important at long exercise durations.

The Effects of Locomotor Training on the Skeletal Muscle Following Spinal Cord Contusion Injury using Magnetic Resonance Imaging
Min Liu, Prodip Bose, Floyd J. Thompson, Glenn A. Walter, Krista Vandenborne
University of Florida, Gainesville, Florida, USA

The goal of this study was to study the impact of locomotor training on skeletal muscle following spinal cord contusion injury using MRI. 3D and T2 weighted images were collected at pre-injury as well as at 1, 2, 4, 8, 12 weeks post injury. This study demonstrates that early intervention strategies can be effectively used to enhance the recovery of muscle mass after SCI. In addition, muscle T2 was initially elevated following spinal cord injury. The T2 of the soleus muscle, a predominantly postural muscle known to be highly susceptible to oxidative stress, was elevated to the greatest extent.

Differentiation of Slow and Fast Twitch Muscles by T2*-Weighted Imaging and Near Infrared Spectroscopy
Noriko Oyama, Toru Yamamoto, Mamoru Tamura, Kazuo Miyasaka
Hokkaido University Graduate School of Medicine, Sapporo, Japan; Hokkaido University School of Medicine, Sapporo, Hokkaido, Japan

To differentiate slow and fast-twitch muscles, we investigated the relationship between changes in T2*-weighted MR signal and hemoglobin oxygenation monitored by near-infrared spectroscopy (NIRS). MRI and NIRS measurements of the human midcalf were performed under a disturbance of blood flow by various compressions in the lower leg. The slope of R2* changes versus deoxygenated hemoglobin changes (‡™R2*/‡™deoxygenHb) in slow-twitch muscle was smaller than that in fast-twitch muscle, especially under severe compressions. We conclude that ‡™R2*/‡™deoxygenHb during graded ischemia by various compressions is a good marker to represent fast and slow-twitch muscles.

Muscle Lipid Content in Multiple Sclerosis Subjects
Hee-Won Kim, Lesley J. White, Sean C. McCoy, Vanessa Castellano
University of Florida, Gainesville, Florida, USA

Common clinical manifestations of Multiple sclerosis (MS) characterized by central nervous system demyelination are excessive fatigue and muscular weakness. 1H-MRS evaluation of intramyocellular lipid (IMCL), and extramyocellular lipid (EMCL) has not been investigated in MS subjects. The purpose of this investigation was to evaluate IMCL EMCL content in moderately disabled of MS patients at rest. IMCL and EMCL levels were not correlated with measures of strength, fatigue or disability even though IMCL level was correlated with knee flexion strength. The use of 1H-MRS to monitor alterations in skeletal muscle following therapeutic interventions may be relevant in monitoring disease states.
14:11 782. 1H Spectroscopic Imaging Measurement of Intramyocellular Lipids in Response to Exercise in Obese and Control Adolescents: A Feasibility Report

Zhiyue J. Wang1, Robert J. Thornton1, Lesley Crabbe2, Zili Chu1, Agneta Sunehag1
1Baylor College of Medicine, Houston, Texas, USA

An increase in intra-myocellular lipid (IMCL) levels causes insulin resistance and increases the risks of type 2 diabetes in adolescents. Proton MRS is used to study the effect of a 12-week exercise protocol on the IMCL levels in the soleus in obese and control adolescents. Chemical shift imaging efficiently provides multi-voxel data with good IMCL and EMCL peak separation from both normal and obese subjects in every scanning session. Data on obese subjects who have completed the protocol suggest that the exercise has the effect of decreasing the IMCL level. This is a preliminary report on an ongoing study.


Arend Heerschap1, Jacco de Haan1, Mireille Serrie2, Cees Tack1, Hans Sauerwein2
1University of Antwerp, University Hospital, Antwerp, Belgium; 2AMC, Amsterdam, Netherlands

Glycogen synthesis rates were determined for whole body muscle by an isotope assessment and locally for the calf muscle (gastrocnemius) by 13C MRS using 13C-1-glucose infusion. The results indicate that the calf muscle glycogen synthesis rate may not account for the average whole body muscle glycogen synthesis rate, which likely is caused by differences in energy metabolism of various muscles or training conditions.

14:13 784. Muscle-Type Specific Intramyocellular Lipid Metabolism during Starvation in Wistar Rats

Claudia Neumann-Haefelin1, Anja Beha1, Johanna Kuhlmann1, Ulrich Beitz1, Hans-Paul Juretschke1, Andreas W. Herling1
1Aventis Pharma Deutschland GmbH, Frankfurt, Germany

The physiological dynamics of IMCL in different muscle types is still uncertain. We therefore investigated the dynamics of IMCL in M.soleus (SOL), M.tibialis ant. (TIB), and M.extensor digitorum longus (EDL) during fed, 12-72h starved and refed conditions in rats by in-vivo 1H-MRS. Despite significant elevation of blood FFA during starvation, IMCL in SOL did not increase. In TIB and EDL IMCL increased significantly during starvation. Refeeding caused a fast drop of elevated IMCL. We conclude that there are muscle-type specific differences in lipid metabolism and there is an increased rate of FFA-reesterification in non-oxidative muscles.

14:14 785. In Vivo 1H NMR Spectroscopic Study of Muscle Lipids in Hyperlipidemic and Diabetic Watanabe Rabbits

Teemu P. Laitinen1, Kimmo K. Lehtimäki1, Himadri Roy1, Sintija Pakalne1, Ilze Kokina1, Seppo Tiia-Herttuala1, Karl-Heinz Herzog1, Juhana M. Hakumäki1
1University of Kuopio, Kuopio, Finland

Metabolite and lipid levels in skeletal muscle of diabetic Watanabe hereditable hyperlipidemic (WHHL) rabbits were studied by 1H NMR spectroscopy in vivo. Our results show that hyperlipidemia and decreased insulin sensitivity in WHHL rabbits is associated with moderate intramyocellular lipid accumulation. However, in diabetic animals, significantly elevated accumulation of intramyocellular lipids could be detected, consistent with increased insulin resistance and hyperlipidemia.

14:15 786. Bone Marrow Fat Content in Osteoporosis: Evaluation with Localized Proton MR Spectroscopy

David Yeung1, James Griffith1, Gregory Antonio1, Francis Lee1, Samuel Wong1, Edith Lau1
1Prince of Wales Hospital, Shatin, Hong Kong

Osteoporosis is a common metabolic bone disease that is evaluated by means of dual energy x-ray absorptiometry (DXA) or quantitative CT (QCT). However, MR-based methods of evaluation of osteoporosis may be able to provide additional information that is currently not obtainable by means of DXA or QCT. We performed 1H MR spectroscopy on 46 elderly females with documented DXA and compared their vertebral bone marrow fat content. Our results showed that 1H MR spectroscopy correlated with DXA and that subjects with reduced bone mineral density (BMD) had significantly higher fat content than age-matched subjects with normal BMD.


Reto Buchli1, Monika Zehnder2, Mirjam Mueller2, Guido Kuehne1, Urs Boutellier2
1University of Applied Sciences, Northwestern Switzerland, Baden, Aargau, Switzerland; 2Swiss Federal Institute of Technology, Zurich, Switzerland; 3Paul Scherrer Institute, Villigen, Aargau, Switzerland

Delayed onset muscle soreness (DOMS) is caused by eccentric exercises and leads to reduced glycogen resynthesis compared to concentric exercises. We attempted to overcome the deceleration of glycogen resynthesis with a diet rich in carbohydrate after eccentric exercise (over 10 g/kg-body-mass/day). All athletes reduced glycogen during two running protocols; 12 performed additional eccentric exercises (DOMS) while 8 rested (CONTROLS). Control subjects reached resting glycogen levels (137 mmol/kg) within 20 hours, while DOMS subjects needed two days and had about 27% lower glycogen levels. Thus, carbohydrate-rich diet was unable to refill the glycogen stores quickly.
14:17  788. **Molecular Dynamics and Information on Possible Sites of Interaction of Intramyocellular Metabolites In Vivo from Resolved Dipolar Couplings in Localized $^1$H MR Spectra**  
*Leif Schröder*, *Christian Schmitz*, *Peter Bachert*  
$^1$Deutsches Krebsforschungszentrum (dkfz), Heidelberg, Germany; $^2$Institut für Physikalische Chemie, Heidelberg, Germany

Residual dipolar couplings of (phospho)creatine, taurine, and carnosine were analyzed by means of high-resolution localized in vivo $^1$H MRS of human m. gastrocnemius. Dipolar coupling constants and the order parameter for molecular mobility were obtained and related to a model of molecular confinement in muscle tissue.

14:18  789. **Orientation Dependent Effects in Spectra of Human Skeletal Muscle Recorded at 1.5 and 3 T**  
*Juergen Machann*, *Günter Steidle*, *Gunther Helms*, *Fritz Schick*  
$^1$Section on Experimental Radiology, Tuebingen, Germany

Due to the highly ordered structure of skeletal muscle proton spectra show distinct orientation dependent features arising from susceptibility (intra- and extramyocellular lipids) and dipolar coupling (creatinine and taurine). Comparative measurements of tibialis anterior (TA) and soleus muscle (SOL) have been performed at 1.5T and 3.0T (both devices SIEMENS, Germany). At 3T IMCL appears with narrower and symmetrical lines, whereas EMCL shows relatively broad and often asymmetrical line shape. In TA signal splittings in the TMA/Tau complex are clearly field dependent. In SOL splitting effects are less prominent for both field strengths, probably due fiber orientation near the magic angle.

14:19  790. **Localised $^{13}$C Spectroscopy in Humans with Outer Volume Saturation**  
*Albrecht Ingo Schmid*, *Michael Roden*, *Ewald Moser*, *Martin Krssak*  
$^1$Vienna Medical University, Vienna, Austria

A new approach to in vivo localised 13C NMR spectroscopy on humans is presented. Surface coil prelocalisation is combined with effective broad band saturation slices to suppress unwanted signals from adipose and bone marrow tissue. Phantom and in-vivo studies show this method to be feasible for oniting skeletal muscle tissue metabolism. 1H-decoupled spectra could be acquired within FDA SAR guidelines.

14:20  791. **Simultaneous $^{31}$P-MR-Spectroscopy and SEMG of the Low Back Muscle – A Methodical Approach**  
$^1$Friedrich-Schiller-University, Jena, Thüringen, Germany

Simultaneous 31P-MRS and SEMG measurements were performed during an isometric muscle contraction (modified Sörensen test) to investigate metabolic and electrophysiologic changes of fatigue on the low back muscle. Artifacts of MR and SEMG measurement signals were sufficiently reduced to obtain usable results. During exercise changing levels of phosphocreatine (PCr) and inorganic phosphate (Pi) were observed and SEMG measurements revealed a decrease of the mean frequency. Simultaneous 31P-MRS and SEMG measurements are feasible and indicate typical metabolic and electrophysiologic changes of fatigue.

14:21  792. **Depletion of Muscle Taurine Levels is Tolerated by the Heart But Results in Severe Impairment of Skeletal Muscle**  
*Ulrich Flögel*, *Ulrich Warskulat*, *Christoph Jacoby*, *Michael Thewissen*, *Marc Mercz*, *Andrej Molojavy*, *Birgit Heller-Stib*, *Jürgen Schrader*, *Dieter Häussinger*  
$^1$Heinrich-Heine-Universität, Düsseldorf, NRW, Germany; $^2$RWTH Aachen, Aachen, NRW, Germany

The effects of taurine deficiency on muscle function were examined in taurine transporter knockout (taut-/-) mice. While cardiac function of taut-/- mice was almost uncompromised, taut-/- skeletal muscle (SM) revealed functional abnormalities and total exercise capacity of taut-/- mice was severely reduced. $^1$H MRS showed that in taut-/- hearts the lack of taurine was compensated by the upregulation of various organic solutes, while a 10 mM deficit in total organic osmolytes was found in transgenic SM. Obviously, taurine is crucial for the maintenance of SM function and total exercise capacity while cardiac muscle can compensate for the loss of taurine.

14:22  793. **Effects of Arthritis on Muscle Bioenergetic Reserve Determined by In-Vivo $^{31}$P Magnetic Resonance Spectroscopy**  
*Craig J. Galban*, *Ilksen Gurkan*, *Richard G. S. Spencer*, *Shari M. Ling*  
$^1$University Hospital of Essen, Essen, Germany; $^2$Johns Hopkins University, Baltimore, Maryland, USA; $^3$National Institutes of Health, Baltimore, Maryland, USA

It is unclear whether muscle dysfunction in arthritis is secondary to disuse-induced atrophy or to specific correlates of the arthritis process. We hypothesized that, in fact, the biochemical and bioenergetic sequelae of arthritis would differ significantly from those of pure atrophy. We investigated muscle function, muscle bioenergetics, cytokine expression, and muscle fiber type in the rat secondary to atrophy, adjuvant-induced arthritis, and a combination of these. Our results suggest that muscle dysfunction secondary to arthritis and to atrophy are distinct.
14:23  794. **A Quantitative Study of Bioenergetics in Carbonic Anhydrase III Knockout Mice by In Vivo $^{31}$P Magnetic Resonance Spectroscopy**

Min Liu¹, Glenn A. Walter¹, Neeti C. Pathare¹, Un-Jin Zimmerman², Robert E. Forster², Krista Vandenborne³
¹University of Florida, Gainesville, Florida, USA; ²University of Pennsylvania, Philadelphia, Pennsylvania, USA

The goal of this study was to investigate the biological importance of carbonic anhydrase (CA) III in energy metabolism of skeletal muscle. $^{31}$P-Magnetic Resonance (MR) spectra were acquired from gastrocnemius muscles of CA III knockout mice. Spectra were collected at rest (10 minutes), during ischemia (30 minutes), and recovery (30 minutes). In general, the mutants' metabolic responses to ischemia appeared similar to wild type's. This study supports the contention that CA III may not play an important role for the function of the system under a mild ischemic stress condition.

14:24  795. **Phosphorylated Guanidinoacetate in Muscle of GAMT Deficient Mice Only Partly Compensates for PCr as Assessed by $^{31}$P MRS and Functional Measurements**

Hermien E. Kan¹, W Klaas Jan Renema¹, Arnold de Haan², Dirk Isbrandt³, Arend Heerschap¹
¹University Medical Center St Radboud, Nijmegen, Netherlands; ²Vrije Universiteit, Amsterdam, Netherlands; ³University of Hamburg, Hamburg, Germany

Skeletal muscle of guanidinoacetate (Gua) methyltransferase deficient (GAMT-/-) mice was studied in vivo by $^{31}$P MRS and by functional measurements. Absolute force as well as the ability to maintain force during repeated contractions were reduced in GAMT-/- hind leg muscle. 31P-MRS showed that GAMT-/- mice can compensate the lack of PCr with the newly formed phosphorylated guanidinoacetate (PGua) during ischemia. The recovery of PGua after ischemia, however, was significantly delayed. Saturation transfer measurements and recovery rate after ischemia following Cr supplementation suggest that reduced enzyme kinetics cause the observed differences in recovery rate and fatigue resistance.

14:25  796. **Correlations of MRI and P-31 MRS Data with Clinical Parameters: Juvenile Dermatomyositis**

Jing Qi¹, Nancy J. Olsen¹, Amanda E. Nelson¹, Jane H. Park¹
¹Vanderbilt University Medical School, Nashville, Tennessee, USA

Juvenile dermatomyositis patients (JDM) were evaluated using MRI, P-31 MRS, and conventional clinical procedures. In statistical comparisons of JDM patients and normal children, muscle ATP levels yielded more highly significant P values than PCr or T1 and T2 relaxation times. Likewise, ATP showed the most significant r and P values for correlations of MR data versus clinical parameters for JDM disease status. With the JDM children, MRS and MRI provided the most reliable data for quantitative disease evaluation and therapeutic planning.

14:26  797. **Comparison of Muscle BOLD and Transcutaneous PO$_2$ Measurements in a Human Postischemic**

Hanns-Georg Heidecker¹, Hans Peter Ledermann¹, Anja Carina Schulte², Markus Aschwanden³, Kurt Jaeger¹, Deniz Bilecen¹
¹Universitätssititut für Diagnostische Radiologie, Basel, Switzerland; ²Biozentrum Basel, Basel, Switzerland; ³Universitätssititut für Angiologie, Basel, Switzerland

In a postischemic hyperemia model time courses of TcPO2- and muscular BOLD-measurements during ischemia show a high correlation (cc = 0.97). Time courses during postischemic hyperemia show baseline overshoot, yet correlate to a lesser degree (cc = 0.26). This evidence shows, that the BOLD-signal-change can be used to detect muscular hypoxia and recovery from hypoxia. The reactive hyperemia peak recorded with TcPO2-measurements lags the BOLD-signal overshoot by 80 seconds, which is most likely due to persistent vasoconstriction of cutaneous and subcutaneous vessels.

14:27  798. **Dynamic Contrast-Enhanced Perfusion MRI in the Femoral Head: Comparison of Two Perfusion Models**

Chun-Ching Huang¹, Yi-Jui Liu¹, Hsiao-Wen Chung¹, Wing P. Chan³
¹National Taiwan University, Taipei, Taiwan; ²Yuan-Pei University of Science and Technology, Hsin-Chu, Taiwan; ³Municipal Wan-Fang Hospital, Taipei, Taiwan

This study investigates the conditions under which dynamic contrast-enhanced MRI can be used for accurate measurements of perfusion parameters in the femoral head. Two models (by Brix and Tofts) were compared, with the effects of frame rate, signal-to-noise ratio, and total examination time evaluated. Results from the Monte Carlo simulations showed that the Tofts model is insensitive to the total duration of examination time, and is superior to the Brix model in femoral head perfusion. Errors less than 3% in all perfusion parameter estimations are achievable at an SNR of 30 and with 10 minutes of total exam time.
Musculoskeletal MR Imaging: Clinical Studies

Room E  Thursday 13:30 - 15:30

13:30  799.  A Comparison of Quantitative and Semi Quantitative MRI Assessment of Synovitis Volume in Osteoarthritis of the Knee
Laura Anne Rhodes¹, Andrew J. Grainger², Anne-Maree Keenan², Paul Emery², Philip G. Conaghan²
¹University of Leeds, Leeds, UK; ²Leeds General Infirmary, Leeds, UK

MRI has been used to compare a semi quantitative synovitis score with a quantitative assessment of synovitis volume in patients with osteoarthritis of the knee in four anatomical sites. The semi quantitative scoring method correlated well with the detailed ‘gold standard’ volume assessments.

13:31  800.  Bone Marrow in the Proximal Femur: Creation of a Method to Get Reproducible Values of MRI Signal Intensity by using Standardized Regions of Interest
Nadir Alexander Ghanem¹, Daniel Schmitz¹, Carsten Altehoefer¹, Henner Sturzenhecker¹, Martin Büchert¹, Mathias Langer¹
¹University Hospital Freiburg, Freiburg, Germany

Observation of bone marrow in the proximal femur enables the detection of changes of bone marrow. The purpose of this study was to show the reproducibility of signal intensity measurements in MRI. Repetitive measurements were taken to validate reproducibility within one observer. In three regions the relative error was lower than 10%. The results of two observers were compared to look for hints onto reproducibility within different observers. Normalized signal intensities in the metaphysis of competitive athletes determined with this method correlate with some hematological data.

13:32  801.  In Vivo Measurement of Trabecular Bone Microarchitecture in the Proximal Femur with MRI at 1.5 T and 3 T
Roland Krug¹, Eric T. Han¹, Suchandrima Banerjee¹, David C. Newitt¹, Sharmila Majumdar¹
¹UCSF, San Francisco, California, USA; ²GE Medical Systems, Menlo Park, California, USA

Recent enhancements in MRI pulse sequence development have made it possible to visualize and quantify the microarchitecture of trabecular bone in the proximal femur in a non-invasive manner. In this work, the microstructure of the trochanter has been analyzed in vivo from high resolution 1.5 T and 3 T MR images. In a preliminary study of six volunteers, reasonable but different values of trabecular structural parameter were found for both field strengths. Reproducibility between 2-4% was obtained for 1.5 Tesla scans and more than 8% for 3 Tesla measurements.

13:33  802.  Relative Performance of FLASE, TrueFISP and Gradient Echo in μ-MRI of Trabecular Bone
Aranee Techarwiboonwong¹, Hee Kwon Song¹, Felix W. Wehrli¹, Punam K. Saha¹
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

In vivo MRI is now feasible as a means to assess the integrity of trabecular bone (TB). Typical approaches used are: 3D gradient echo (GE) and Fast 3D Large-Angle Spin-Echo (FLASE). Spin-echo sequences are advantageous since they are less sensitive to intensity distortions near the TB marrow interface. An alternate approach is 3D TrueFISP, which is known to have spin-echo like properties under certain conditions. In this work, the performance of FLASE, TrueFISP and GE was evaluated for their efficiency (SNR/unit time) and effects on the derived apparent TB thickness. Results show that FLASE outperforms the other two sequences.

13:34  803.  Predicting Bone Strength with SPENT (Sub Pixel Enhancement of Non-Uniform Tissue) and R₂¹
David W. Carmichael¹, Marios Yiannakas², Mic Farquharson², Roger J. Ordidge¹
¹University College London, London, UK; ²City University, London, UK

MRI methods have found restricted application in a clinical setting for the assessment of bone fracture risk, due to limitations of resolution and sensitivity. A new method called SPENT is investigated in conjunction with the relaxation rate R₂, to predict bone strength without requiring very high resolution images. Measurements of SPENT and R₂ were compared to Young’s Modulus (YM) and Bone Mineral Density (BMD) for thirty samples from the human femur. The average normalised SPENT value provided a close correlate to BMD (r²=0.856, p<0.0001), and when combined with R₂, provided an improved correlation to YM than the BMD.

Imran Muhammad Omar¹, Mark Schweitzer²
¹Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA; ²New York University Hospital for Joint Diseases, New York, New York, USA

Bipartite patella is seen most frequently in younger male patients. We utilized magnetic resonance imaging to determine the incidence, examine the age and gender dependence and describe imaging characteristics of bipartite patella. Its epidemiology, location at the superolateral aspect of the patella and its association with a single patellar cartilage suggests trauma, which may incompletely heal, as the most common etiology for this entity. Edema in the synchondrosis and in the adjacent bone marrow may reflect abnormal motion that can be a source of anterior knee pain in young adults.
This study was aimed to demonstrate the utility of microscopic images with FOV of 50 mm and thickness of 1.5 mm in delineation of the medial meniscus of the knee. 26 patients with clinically suspected internal derangement of the knee were examined by routine and microscopic imaging. Compared to the routine images with FOV of 150 mm, a qualitative image analysis using a four-point scale was performed. MR microscopy delineated tiny cleavages in cases with meniscal tears. The mean values of qualitative evaluation of the MR microscopy were significantly higher than those of the routine imaging.

Recurrent lateral patellar dislocation (RLPD) commonly occurs in young women. MRI is helpful in the diagnosis of RLPD, and may be able to play a significant role in directing surgical management if it can accurately depict the medial patellar stabilizer. The introduction of microscopy coil (diameter of 47mm) allows us to acquire high resolution MRI (HR-MRI). We used the microscopy coil on the patella and reviewed its advantages in the diagnosis of RLPD. The purpose of this study is to determine the usefulness of HR-MRI using microscopy coil for the precise evaluation of RLPD.

Carpal tunnel syndrome is a work related upper limb disorder and is the commonest peripheral neuropathy. This disease results from compression of the median nerve. The purpose of this study was to quantify the migration of tendons towards the median nerve during maximum pinching.

The purpose of this project was to evaluate the existence and characteristics of the transverse humeral ligament using MR imaging. Following examination of cadaveric shoulders using MR imaging as well as gross and microscopic anatomic dissection, what was discovered was the absence of an actual transverse humeral ligament. Instead, fibers covering the intertubercular groove are composed of a sling formed by fibrous contributions from the subscapularis and supraspinatus tendons, thus suggesting a relationship between tears of the subscapularis tendon and the anterior portion of the supraspinatus tendon.

Purpose: To assess the usefulness of dynamic MRI in distinguishing high-flow from low-flow vascular malformations. MATERIALS AND METHODS: Sixteen patients with vascular malformation (6 high-flow and 10 low-flow malformations) underwent MRI. RESULT: The sensitivity of flow voids for differentiating high-flow and low-flow malformations was 50% (3/6) and specificity 100% (10/10). The sensitivity of arterial-lesion enhancement time was 100% (6/6) sensitivity and 60% (6/10) specificity. The sensitivity of arterial-lesion enhancement time was 100% (6/6) sensitivity and 100% (10/10) specificity. CONCLUSION: Dynamic MRI is useful for differentiating high-flow from low-flow vascular malformations.

Magnetic Resonance Imaging has been used in an attempt to prospectively diagnose Piriformis Syndrome. In a blinded review of MRI studies, these included aberrant sciatic nerve course, piriformis muscle size, presence of perisciatic masses, and presence of perisciatic fibrovascular structures. We found no correlation of piriformis muscle size or fibrovascular structures to the side of patient symptoms. Aberrant course of the sciatic nerve and perisciatic muscles were rare, but seemed causative of symptoms.
The purpose of this study was to observe changes in T2 measurements of knee cartilage in 12 patients with OA between a baseline and follow-up exam. All patients had two scans with a mean time between the baseline and follow-up scan of 680 days (range 400 - 1050 days). Four cartilage compartments were analyzed: the medial and lateral femur and tibia. The mean T2 was found to increase significantly (p < 0.05) between the baseline and follow-up exams for patients who had two scans with a mean time between the baseline and follow-up scan of 680 days (range 400 - 1050 days). Four cartilage compartments were scanned with SSFP and TSE. Preliminary results support equivalent image quality and fat suppression with PS-SSFP and FSE, and superior PS-SSFP delineation of cartilage.

Musculoskeletal MR Imaging: Cartilage

Room E Monday 14:00 - 16:00

14:00 814. A Two-Year Longitudinal Study of the Interrelationship between Trabecular Bone and Articular Cartilage of the Osteoarthritic Knee

Gabrielle Blumenkrantz, Colleen Lindsey, Joe Adolfo, Michael Ries, Sharmila Majumdar

1University of California, San Francisco, San Francisco, California, USA
2University of California, Berkeley, Berkeley, California, USA

This study evaluates the relationship between structural changes of bone and cartilage in patients with varying degrees of OA (of the knee) over the course of two years, using in vivo MR imaging. The results indicate that in the femur, bone and cartilage structural parameters decrease over time in patients with OA. Furthermore, this study demonstrates that cartilage degeneration in the knee joint is associated with changes in bone structure.

14:01 815. A Longitudinal Study of T2 Changes in Articular Cartilage of the Osteoarthritic Knee

Timothy C. Dunn, Gabrielle Blumenkrantz, Colleen Lindsey, Michael Ries, Sharmila Majumdar

1University of California, San Francisco, San Francisco, California, USA
2University of California, Berkeley, Berkeley, California, USA

The purpose of this study was to observe changes in T2 measurements of knee cartilage in 12 patients with OA between a baseline and follow-up exam. All patients had two scans with a mean time between the baseline and follow-up scan of 680 days (range 400 - 1050 days). Four cartilage compartments were analyzed: the medial and lateral femur and tibia. The mean T2 was found to increase significantly (p < 0.05) between the baseline and follow-up exams for all cartilage compartments except the lateral tibia. Quantification of OA disease factors such as T2 longitudinally could prove clinically valuable.

14:02 816. Improved Reliability of Cartilage T2 Measurements using a Leg Positioning Device

Timothy John Mosher, Yi Liu, Michael Bruce Smith

1Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania, USA

The purpose of this study is to determine the impact of a leg-positioning device on variability of in vivo cartilage T2 measurements of the femoral tibial joint. Quantitative T2 maps were performed on 6 normal volunteers using a test-retest protocol. Variability in T2 was determined by measuring a pooled coefficient of variation (CVT) as a function of normalized distance from bone. Excellent reproducibility was obtained with CVT values ranging from 1% to 3% for femoral and tibial cartilage. Devices for reproducibly positioning the extremity are recommended for multi-center or longitudinal clinical trials using MRI in the evaluation of articular cartilage.
Quantitative cartilage T2 mapping was performed on 2 patients with Stickler syndrome, a rare connective tissue dysplasia characterized by abnormal type II collagen in cartilage resulting from mutations of the type II procollagen gene (COL2A1). Both Stickler patients demonstrated significantly elevated cartilage T2, more than 3 standard deviations above normal, consistent with the hypothesis that cartilage T2 is sensitive to the content and organization of the collagen matrix in cartilage. Sensitivity of cartilage T2 mapping to alteration of the collagen matrix makes it a potential image marker to study the phenotypic expression of different genetic mutations of the COL2A1 gene.

The relationship between T1(GdDPTA) and GAG in dGEMRIC assumes T1 without contrast (T1o) and relativity (r) are constant across tissue. Since GdHPDO3A distributes uniformly in cartilage, any variation of T1(GdHPDO3A) is due to T1o and relaxation variation across the tissue. With total GAG depletion an increase of 3, 5 and 15% was observed in T1 with GdHPDO3A at 8.45, 4.7 and 1.5T. Thus for completely degraded tissue dGEMRIC predicted GAG will be slightly higher than actual tissue GAG. Since the effect is relatively linear with GAG, relative GAG distribution can be inferred.

In view of osteoarthritis, diffusion tensor imaging (DTI) was used to analyze the microstructure of bovine hyaline articular cartilage in cartilage-on-bone samples. Imaging experiments were performed on a high-field MRI system at an in-plane spatial resolution of 62x62µm². Measurements were performed both unloaded and under local compressive strain. Diffusion tensor trace, anisotropy, eigenvalues, and eigenvectors were calculated and visualized. The maps show a zonal arrangement for unloaded cartilage. This pattern is strikingly modified under loading. These findings are in agreement with current literature about the collagenous fiber architecture of cartilage. Therefore, DTI experiments seem applicable to articular cartilage structural analysis.

Magnetic resonance imaging has successfully been used to visualize cartilage of the knee. Currently, the most widely used techniques for imaging cartilage are fat suppressed proton-density weighted and T2-weighted fast spin-echo, and fat suppressed T1-weighted gradient-echo sequences. However, there is an increasing demand for cartilage imaging techniques that are faster, have an increased contrast to noise ratio between cartilage and its surrounding tissue, are fat suppressed proton-density weighted and T2-weighted fast spin-echo, and fat suppressed T1-weighted gradient-echo sequences. However, there is an increasing demand for cartilage imaging techniques that are faster, have an increased contrast to noise ratio between cartilage and its surrounding tissue, show less blurring of the cartilage and show a sharper delineation of cartilage contours. These requirements make a water selective steady-state free precession technique, described in our study, ideal for cartilage imaging.

We developed an algorithm for calculating the true positive and true negative fraction for different raters segmenting articular cartilage. Results show agreement among different rater's TPF and divergence among rater's TNF. These results are indicative of the difficulty of correctly excluding tissues adjacent to articular cartilage in the femur. The algorithm will be useful for evaluating different segmentation methods.

The size of focal lesions in Osteoarthritis has been shown to be an indicator of disease evolution. Currently, arthroscopy is considered the gold standard for lesion examination but subject to invasiveness and rough estimation of lesion dimensions. This study was to validate a Gradient Peak Method using MRI to quantify lesion thickness, area and eroded volume. First, a controlled lesion validation showed that GPM provided fair precision on lesion dimension estimations and its accuracy was within the imaging error. Second, a comparison with arthroscopy also confirmed the ability and accuracy of GPM in reproducing and quantifying lesion morphology.
14:09 823.  Preliminary Experience with dGEMRIC at 3.0 T
Tali Kimelman1, Anthony Vu1, Belinda Li2, Pippa Storey2, Ashley Williams2, Charles A. McKenzie2, Deborah Burstein3, Pottumarthi V. Prasad2
1Northwestern University, Evanston, Illinois, USA; 2Evanston Northwestern Healthcare, Evanston, Illinois, USA; 3Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

To-date all of the reported dGEMRIC studies have been done at 1.5 T. Implementation at 3.0 T requires knowledge of the relaxation times at that field strength. In this study, cartilage T1 was found at 3.0 T (1.5T) to be on the order of 1300 ms (900 ms), with post-contrast values of 720 ms (570 ms) in asymptomatic individuals and as low as 470 ms (307 ms) in a “lesion”. The longer T1s and lower relaxivity at 3.0T may offset the SNR advantage, however the potential of doing a combined dGEMRIC and morphologic study at 3.0T may override this concern.

14:10 824.  Measurement of Dipolar Oscillations in Articular Cartilage using Spin-Lock Technique
Sarma V. S. Akella1, Ravinder R. Regatte1, Andrew J. Wheaton1, Arijitt Borthakur1, Ravinder Reddy1
1University of Pennsylvania, Philadelphia, Pennsylvania, USA

The purpose of this study is to measure the residual dipolar oscillations (REDIOS) in articular cartilage using spin lock technique. We investigated the dispersion of REDIOS as a function of spin lock frequency (ω1) and found that REDIOS increase with ω1 up to about 3kHz. We found that the REDIOS are not altered by proteoglycan (PG) depletion, indicating that the oriented collagen structure may be the primary source of dipolar interaction in cartilage.

14:11 825.  Manganese as a Contrast Agent for Articular Cartilage
Gil Navon1, Hadassah Shinar1, Keren Keinan-Adamsky1, Galit Saar1, Anthony H. Aletras2
1Tel Aviv University, Tel Aviv, Israel; 2National Institutes of Health, Bethesda, Maryland, USA

Intraarticular injection of Mn2+ was tested as an alternative to Gd(DTPA)2− as a contrast agent for articular cartilage. For porcine knee joints, T1 of the cartilage decreased from 500 ms in the control to 160 ms, 10 minutes after injection of 1mM MnCl2. A clear delineation between the cartilage and the synovial fluid was obtained. The manganese-enhanced T1 weighted intensities and their time course were found to be very sensitive to depletion of proteoglycans from cartilage-bone plugs. Thus manganese should be considered as a possible diagnostic tool for enhancing the contrast of articular cartilage and monitoring proteoglycans depletion.

14:12 826.  MRI Follow-up of Knee Joint After Intra-articular Injections of Allogeneic Mesenchymal Stem Cells in a Caprine Model of Partial Medial Meniscectomy
Izlem Izbudak1, Michelle A. LeRoux2, Loralie D. Ma1, Raymond C. Boston2, Danielle Fritzes1, Frank P. Barry2, Dara L. Kraitchman1
1Johns Hopkins University, Baltimore, Maryland, USA; 2Osiris Therapeutics, Inc, Baltimore, Maryland, USA; 3Advanced Radiology, Baltimore, Maryland, USA; 4University of Pennsylvania, Kennett Square, Pennsylvania, USA

Using a goat model of partial medial meniscectomy, MRI was used to track meniscal repair in non-treated controls (n=5) and animals receiving intra-articular allogeneic mesenchymal stem cells (n=5, MSCs). Serial scans were performed prior to injection and at 6, 24, and 48 weeks post-injection. MRI showed an increase in medial meniscal size both qualitatively and quantitatively. The truncated shape of the posterior horn of the medial menisci at baseline returned to a more normal triangular shape after 6 months. MRI was unable to detect changes in the meniscus at 6 weeks. However, regrowth could be evaluated by 6 months post-treatment

14:13 827.  MRI Remains the Method of Choice in Testing Disease Modifying Osteoarthritis Drugs
Rod Pickford1, Jean J. Tessier1, Nicola J. Brownrigg1, Jonathan Bowyer1, Brian Middleton1, Maureen Horrocks2, Rose A. Maciewicz2, John C. Waterton1
1AstraZeneca plc, Macclesfield, UK

This study compared medial tibial plateau cartilage volumes measured by MRI in the Guinea Pig model of OA with urinary biomarkers of type II collagen degeneration pre & post dosing of a metalloproteinase inhibitor, to evaluate their use as a tool to evaluate Disease Modifying Osteoarthritic Drugs (DMOADs). MRI is an accurate and statistically powerful measurement of drug effect, in contrast in this disease model, urinary biomarkers is shown not to be feasible for the evaluation of DMOADs without the use unacceptably large numbers of animals
MR images of ten patients with mucinous carcinoma (eight pure forms and two mixed forms) of the breast were reviewed to disclose differences in MR findings between the two forms, with correlating with pathological findings. Both pure-form and mixed-form of mucinous carcinoma of the breast showed very high signal intensity on T2-weighted MR images. On dynamic study, pure-form tumors showed gradual enhancement pattern, whereas mixed-form tumors showed early enhancement pattern. Dynamic MR imaging may be useful for differentiation between pure-form and mixed-form tumors.

Dynamic contrast enhanced MRI of the breast were acquired with 4 - 7 seconds time resolution for the first 90 seconds after contrast media injection. Data were analyzed to produce 'AUC30' images - the integral of contrast media concentration-time curve for the first 30 seconds after bolus arrival. Small DCIS are much more clearly depicted in AUC30 images than in conventional difference images (venous minus arterial phase). Most of the images acquired to date demonstrate significant changes in morphology of the enhancing region over 90 seconds after injection. Our studies suggest high temporal resolution sampling (HiTS) improves diagnostic accuracy of DCIS.

Effective fat suppression in images is of major importance for dynamic contrast enhanced MRI of breast cancer. Current approaches rely on subtraction, fat suppression or water excitation. Selective saturation or excitation require high field homogeneity, which can often present a challenge, and may result in longer measurement times and increase power deposition. Subtraction imaging will not completely remove fat, since fatty tissue enhances to some extent. In this abstract we propose a post-processing method of fat suppression using Principal Components Analysis (PCA). The algorithm and the results of our initial valuation are presented.

The VIBE (volume interpolated breath-hold examination) sequence in combination with parallel acquisition technique (PAT) allows dynamic MRI of the breast with high temporal and spatial resolution. Supine MRM (surgical position) using the GRAPPA (generalized autocalibrating partially parallel acquisition) algorithm was performed in 35 patients with breast cancer. The sensitivity and specificity for the detection of intraductal extension were 71% and 100%, respectively. Accuracy for the detection of tumor extent with a deviation of less than 2 cm in length was 89% (31/35) Supine MRM using VIBE with PAT is thought to be a promising method for surgical navigation.

A novel gelatin marker has been developed which is visible in MRI, ultrasound (US) and X-ray imaging. The marker was composed of iron containing aluminium and glass microspheres suspended in a gelatin matrix. The aluminum and glass content was adjusted to provide optimal T2* for MRI contrast and reflectivity for US contrast. By the use of microspheres, US contrast was independent of marker orientation. The marker can be easily delivered by a 12 or 14 gauge biopsy needle and forms an alternative to traditional wire localization currently used for breast surgical procedures.

MRI is the most sensitive modality for the visualisation of breast lesions. In conclusion, it should be the preferred imaging method for the guidance of breast biopsies. Due to the complicated handling and long examination duration, current MRI-guided breast biopsy procedures have not yet gained broader impact on patient treatment. Active markers may help to overcome these difficulties. We demonstrate their applicability for measuring the biopsy needle position and automation of the biopsy planning process. Potential improvements include: facilitated handling, increased safety, time savings of up to 50%, and a more precise targeting of smaller lesions.
Breast MR Spectroscopy

Room E  Wednesday 13:30 - 15:30

13:30  834.  The Effects of Breast Radiographic Markers on MRI and MRS: Ex Vivo Testing of Artifacts at High Magnetic Field (4 Tesla)
Sina Meisamy1, Patrick J. Bolan1, Ryan Chamberlain1, Joseph Lin1, Michael T. Nelson1, Lenore I. Everson1, Timothy Emory1, Douglas Yee1, Michael Garwood1
1University of Minnesota, Minneapolis, Minnesota, USA

The purpose of this study is to evaluated 6 FDA-approved breast radiographic markers (RM), which were originally designed for visibility under mammography and ultrasound, from 5 manufacturers and compared the MRI and MRS artifacts each produced at high magnetic field (4T). The results show that the titanium and carbon zirconium oxide RM produced the least amount of imaging and spectral artifact.

Gillian M. Egan1, Patrick J. Gilligan2, Patrick A. Kenny1, Fidelma Flanagan3
1Mater Misericordiae University Hospital, Dublin, Ireland; 2Mater Private Hospital, Dublin, Ireland; 3Breast Check, Dublin, Ireland

Using MRS increased amounts of choline are observed in breast tumours. Conventional pulse sequences are limited for choline detection, as fat and water dominate the spectrum. ACE suppresses these unwanted signals. The purpose of this research was to evaluate the ACE sequence for a phased array coil on a 1.5T magnet and to compare different sequences and coils for performing breast MRS The study included SNR measurements, comparison of coil/sequence combinations and a blinded observer study. The phantom study showed that at low choline concentrations ACE outperformed the conventional STEAM and PRESS sequences.

13:32  836.  Correction of B0 Field Inhomogeneities Improves Susceptibility-Weighted Breast Echo Planar Spectroscopic Images
Jennifer L. Taylor1, Milica Medved1, Weiliang Du1, Gillian Newstead1, Gregory S. Karczmar1
1University of Chicago, Chicago, Illinois, USA

High spatial and spectral (HiSS) magnetic resonance (MR) images are acquired using echo-planar spectroscopic imaging (EPSI) to obtain a detailed proton (1H) spectrum from each pixel. The detailed structure of the spectral water line can provide new and diagnostically useful information that is obscured by macroscopic gradients of the B0 field. Post-processing methods can evaluate and correct these gradients to reveal subtle variations in frequency that reflect clinically relevant local anatomy and physiology. We present a method for correcting B0 field inhomogeneities in HiSS images, and demonstrate application of the method in human breast.

13:33  837.  A Comparison of Inversion Recovery and Selective Excitation for Observation of Choline in Normal Breast Tissue
P Clara Tan1, Martin Lowry1, David J. Manton1, Lindsay W. Turnbull1
1University of Hull, Hull, UK

An investigation of inversion recovery (IR) and selective excitation approaches aimed at optimising choline visibility in spectra of breast lesions is reported here. We found that very short TI’s are required to null the lipid peak with IR, and these TI’s vary greatly between people. On the other hand, removing water and lipid peaks with selective excitation revealed choline in some volunteers at 1.5T. This suggests a greater utility for selective excitation over IR for lesion diagnosis and follow-up in clinical practice.

MR of Lung: Ventilation and Perfusion

Room E  Thursday 13:30 - 15:30

13:30  838.  Visualisation of Aerosolized Perfluorcarbon in the Pig Lung In-Vivo by 19F MRI
Lubos Budinsky1, MA Kandler1, M Chada1, S Mückstein1, W Rascher1, K Brune1, A Hess1
1FAU Erlangen-Nuernberg, Erlangen, Germany

The effect of aerosolized perfluorocarbon (PFC) on pulmonary gas exchange and lung mechanics in a surfactant depleted piglet model was studied by non-invasive 19F MRI. MRI was performed on a 1.5T scanner using RARE sequence on fluor frequency. The spatial distribution of PFC within the lung over the time was described using k-means cluster analysis. Fluor signal persisted in the lungs 30 minutes after the therapy. Fluor signal could be detected for PFC flow lower than 8 ml/kg/h. We assumed that we measured not only condens PFC, but also part of the PFC aerosol.
The strong local gradients in the lung tissue lead to a very rapid signal decay in gradient echo sequences. The application of fast True-FISP sequences at 0.2 T is well suited to subsecond lung parenchyma imaging. Arterial spin labelling experiments of the lung of volunteers were performed on a open 0.2 T scanner using a novel FAIR-True-FISP technique. Perfusion images of the lung showed good image quality and the obtained quantitative results of perfusion rate are in good agreement with physiological data. It is demonstrated that FAIR-True-FISP sequences are suitable in quantitative perfusion imaging of the lung at 0.2 T.

MR ventilation-perfusion imaging using oxygen-enhanced and arterial spin labeling techniques was performed in healthy and asthmatic subjects. Pulmonary ventilation and perfusion defects were observed in subjects with asthma and showed improvement after inhalation of a bronchodilator (albuterol).

Pediatric patients with congenital heart diseases often exhibit complex lung perfusion even after surgical correction. In this study a bolus chasing method was proposed to assist identification of hemodynamic phases in contrast-enhanced perfusion MRI. Series of correlation maps were generated from a pixel-by-pixel calculation of the Pearson’s correlation coefficient between each time course and a time-shifted template selected from the pulmonary artery. With successful elimination of re-circulation effects, atypical signal intensity (SI) time-response, and motion-related SI intensity fluctuations, this method clearly visualized the perfusion pathway and facilitated clinical evaluation of cardiopulmonary circulation in congenital heart disease.

We present the results of a T1-weighted 3D DCE-MRI analysis of lung parenchyma without breath-hold, using short echo time gradient echo acquisition and time series registration. We demonstrate the feasibility of determining absolute quantitative microvascular functional parameters using the adiabatic approximation to the tissue homogeneity model of contrast agent kinetics, generating estimates of blood flow, blood volume, extraction fraction, and capillary permeability surface area product. The values obtained are compatible with previously published pulmonary perfusion data.

In this study we compare regional ventilation and perfusion ratios (V/Q) obtained using hyperpolarized helium-3 MRI to regional V/Q results obtained using nuclear medicine techniques in a porcine model. The methods are compared in normal pigs and in pigs with simulated vascular occlusion. The results indicate a strong correlation between the two imaging methods.

We present a new method for imaging ventilation-perfusion (V/Q) ratios in the lung. The method takes advantage of the unique NMR properties of inert fluorinated gases, namely the dependence of the fluorine T1 on alveolar gas composition.
Partial parallel imaging method (ASSET) was successfully applied to pulmonary ventilation-perfusion imaging using oxygen-enhanced and arterial spin labeling techniques to achieve improvement in spatial resolution in 15 healthy subjects. Compared to non-ASSET acquisition, oxygen-enhanced ventilation and FAIR perfusion images show sharper pulmonary vessels.

The purpose of this study is to compare the VA/Q ratios obtained using hyperpolarized 3He MRI with those obtained using the multiple inert gas elimination technique. Both methods were employed, and comparison of the frequency distribution histograms generated for each suggests a correlation between the two methods.

Chronic obstructive pulmonary disease (COPD) is associated with significant changes in pulmonary ventilation and perfusion. Recent data suggests that pulmonary vascular dysfunction occurs early in the development of COPD. We assessed the heterogeneity of pulmonary blood flow in asymptomatic smokers and patients with COPD using arterial spin labeling techniques (ASL-FAIRER). A significant increase in blood flow heterogeneity was seen in all patients with COPD and in 2 of the 3 asymptomatic smokers when compared to normal subjects. This preliminary data suggests that MR imaging might identify early changes of COPD that occur prior to the development of clinical symptoms.

Alveolar ventilation/perfusion ratio is a key parameter in functional imaging of the lung. Herein, regional V/Q Yorkshire pigs were calculated from regional values of alveolar partial pressure of oxygen measured by hyperpolarized gas MRI. Calculated V/Q values were analyzed by preparing frequency distributions for the entire lung, and compared to V/Q frequency distributions previously established in the literature as normal using other diagnostic techniques.

The aim of this study was to evaluate ozone induced pulmonary oedema using proton MRI. Animals were acutely challenged with ozone and imaged up to 32 days post challenge. At 24 h, large oedematous areas were measured together with corresponding increases in lung volume. Over time the oedematous signal reduced and was replaced by a fibrous looking signal within the pulmonary cavity. Longitudinal assessment of ozone exposed animals may provide important information regarding oxidative-stress induced lung injury and inflammation.
Near-Infrared Fluorescence Reflectance (NIRF) Imaging and Histology Confirm Anomalous Edematous Signal Distribution Detected in the Rat Lungs by MRI After Allergen Challenge

Bruno Tigani1, Hans-Ulrich Gremlich1, Catherine Cannet1, Alexandra Sutter1, Nicolau Beckmann1
1Novartis Institutes for BioMedical Research, Basel, Basel-Stadt, Switzerland

NIRF imaging was applied to detect the distribution of an intra-tracheally (i.t.) instilled fluorescent dye, Cy5.5, to study the relationship between deposition of the dye and the development of pulmonary inflammation elicited by allergen administered i.t. A predominant distribution of Cy5.5 on the left lobe was found, paralleling the localized development of allergic pulmonary inflammation in the left lobe detected as edematous signal by MRI. This difference in the distribution may be due to the inherent geometry of the bronchus of each lobe with respect to the right primary bronchi. Histology confirmed the asymmetrical distribution of pulmonary inflammation.

Assessment of Pulmonary Inflammation in Allergic Rats after Antigen Challenge by MRI

Simon S. Young1, Elaine Cadogan1, Ian Oakley1, Alan Young1, David Checkley1, Rod Pickford1, Jean JL Tessier2
1AstraZeneca, Charnwood, UK; 2AstraZeneca, Macclesfield, UK

Allergic rats develop pulmonary inflammation after antigen challenge. In this study we shown that this can be quantified by proton MRI using sequences with short echo time (TE). Allergic rats developed mild inflammation after one antigen challenge and marked inflammation after two challenges. The increase in inflammation assessed by MRI imaging paralleled the increase in eosinophils in the broncho-alveolar lavage. The inflammation was largely confined to the anterior part of the lung.

Proton MRI Parameters of Lung Disease Following Bleomycin Induced Inflammation in the Rat.

Jayne Hammersley1, Albert L. Busza1, Nadeem Saeed1, Alan White1, Heather l. Lloyd1, David G. Reid1, Michael Salmon1, David C. Underwood2, Ruth R. Osborne2, Kumar Changani1
1GlaxoSmithKline plc, Welwyn, Hertfordshire, UK; 2GlaxoSmithKline plc, Upper Merion, Pennsylvania, USA

Proton MRI of lung parenchyma was acquired serially over a 29 day period following induction of fibrotic disease in the rat. Bright, homogeneous signals a few days after challenge suggest oedema; these give way to more diffuse fibrous networks later. T2 values show a gradual progression away from oedema to protein over the time period suggesting, lung fibrosis. This study demonstrates the utility of proton MRI to characterise the development of chronic obstructive pulmonary disease in a rat model. Information from a single imaging session can provide inflammatory volume, compensatory lung volume and T2 value of lung composition changes.

The Hypoxia-Induced Acute Chest Syndrome of Transgenic Sickle Mice: Comparison between the Micro MR Images and Histo-pathological Findings

Hidemasa Uematsu1, Masaya Takahashi2, Toshio Asakura2, Ichiro Hasegawa2, Hiroto Hatabu2
1University of Fukui, Fukui-city, Fukui, Japan; 2Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA; 2Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA

Acute chest syndrome (ACS), a syndrome caused by the occlusion of pulmonary blood vessels by rigid sickled cells, is a leading cause of mortality with sickle cell disease. The aim of this study was to substantiate the usefulness of the micro MR imaging as a diagnostic tool for ACS in transgenic (Tg) sickle mice. The lobes of the unilateral lung of the Tg sickle mice were subjected to micro MR imaging. The micro MR images showed good agreement with gross pathologic findings. Micro MR imaging may be useful for early diagnosis of acute chest syndrome in sickle cell disease.

MR of Lung: Novel Function and Models

Room E  Tuesday 13:30 - 15:30

Functional Imaging of Human Lung using \( T_2^* \)

Eberhard Daniel Pracht1, Johannes Friedrich Thomas Arnold1, Tungte Wang1, Peter Michael Jakob1
1University of Wuerzburg, Wuerzburg, Germany

In this work, a technique is presented for functional \( T_2^* \) mapping of the human lung. The purpose of this study was twofold: First, we demonstrate the ability to obtain pixelwise \( T_2^* \) values of the whole lung. Second, we investigate the \( T_2^* \) behaviour under normoxic and hyperoxic conditions to obtain functional information of the human lung. Under hyperoxic conditions, the \( T_2^* \) is significantly shortened (to 90% of normoxic conditions).
Cigarette smoking is the most important risk factor of chronic obstructive pulmonary disease (COPD). Several investigators try to evaluate smoking-related functional loss due to CT, although CT can only demonstrate regional morphological change in lung parenchyma. Oxygen-enhanced MR imaging offers an alternative approach for assessment of regional pulmonary function. We hypothesized that oxygen-enhanced MR imaging may have a potential for assessment of the functional loss due to cigarette smoke, when compared with density-masked CT (quantitative CT). The purpose of the present study is to demonstrate the capability of oxygen-enhanced MR imaging for assessment of smoking-related COPD.

**13:32 857. Correlation of Proton Spin Density with $T_1$ Relaxation of the Lung in Patients with Cystic Fibrosis**

Tungte Wang1, Georg Schultz2, Helge Hebestreit1, Alexandra Hebestreit1, Eberhard D. Pracht1, Johannes F. T. Arnold1, Dietbert Hahn1, Peter M. Jakob1

1University of Würzburg, Würzburg, Bavaria, Germany

Correlation of proton spin density, M0, with T1 relaxation of the lung was studied in ten patients with cystic fibrosis (CF). A lung T1 map and the corresponding lung M0 map in each patient were acquired simultaneously during a single breathhold on end-expiration using a rapid 1H MR T1-mapping technique in order to measure M0 and T1 values. The results reveal that in each patient with CF, higher lung M0 correlates with normal lung T1 and lower lung M0 correlates with abnormally decreased lung T1. This could be well explained by the two-compartment, T1-relaxation model.

**13:33 858. Single Point Imaging (SPI) of Lung Tissue**

Anthony Price1, Malcolm Prior1, Albert Busza1, Peter Morris1

1University of Nottingham, Nottingham, UK; 2GSK, Welwyn, UK

Lung parenchyma can be successfully imaged using Single Point Imaging. SPI is normally only used for imaging solids but is ideal for overcoming the problem of magnetic inhomogeneity caused by the difference in susceptibility between air and tissue. SPI images have been acquired of rat lung showing excellent SNR from the lung tissue. This method could be used to detect subtle changes in lung morphology via T2* and T1 weighting.

**13:34 859. Initial Orientational Lung Imaging in an Open-Access Human-Scale Low-Field MRI System**

Ross William Mair1, Mirko I. Hrovat1, Sam Patz1, Matthew S. Rosen1, Julian C. Ruser1, George P. Topulos1, Leo L. Tsai1, Bill Hersman1, Ronald L. Walsworth1

1Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA; 2Mirtech, Inc., Brockton, Massachusetts, USA; 3Brigham and Women's Hospital, Boston, Massachusetts, USA; 4University of New Hampshire, Durham, New Hampshire, USA

There is considerable evidence suggesting gravity plays a significant role in lung structure and function. Laser-polarized 3He MRI provides a powerful method to study lung function and inhalation, but in traditional MRI systems, patients are restricted to lying horizontally. A prototype open access, human-scale MRI system allowed for complete two-dimensional rotation of subjects within the applied field, by exploiting the ability to detect laser-polarized 3He at very low applied magnetic fields. Two-dimensional 3He lung inhalation images were obtained from a subject in horizontal and vertical orientations. A second generation system with improved B0 homogeneity and gradient switching is being developed.

**13:35 860. MR Imaging of Diaphragmatic Motion: Effect of Positions in Normal Subjects**

Shigeru Kiryu1, Masaya Takahashi1, Yasutane Mori1, Masaomi Kuroki1, Mizuki Nishino1, Neil M. Rofsky1, Hiroto Hatabu1

1Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, Massachusetts, USA

The hemidiaphragmatic motions during breathing were assessed in 8 subjects using dynamic MRI in supine, prone, and right and left decubitus positions. The diaphragmatic excursion of the right lung was significantly larger in supine, prone and right decubitus. The right and left diaphragms had same velocities and moved synchronously in supine and prone positions. By contrast, in decubitus positions, the dependent diaphragm had higher velocity and completed the expiration earlier whereas it had same velocity but completed the inspiration later than the non-dependent diaphragm. MR imaging provided quantitative information on excursion, synchronicity and velocity of hemidiaphragms.

**13:36 861. Dynamic MRI of the Upper Airways in Subjects With and Without COPD**

Klaus Kurt Gast1, Sebastian Ley2, Alexander Biedermann1, Anja Rist1, Wolfgang G. Schreiber1, Hans-Ulrich Kauzcor2, Claus-Peter Heusser1

1Klinikum der Johannes Gutenberg-Universitaet, Mainz, Germany; 2German Cancer Research Center, Heidelberg, Germany

To investigate differences in the dynamic behaviour of the upper airways between normal subjects and COPD patients, dynamic MRI of the upper respiratory tract was evaluated concerning airway diameter at three different levels during continuous respiration. Fifteen healthy volunteers and 23 COPD patients were included. Median respiratory narrowing of the upper trachea was significantly stronger in COPD patients (64%) than in volunteers (43%). This enhanced airway narrowing might hamper distribution of inhalation drugs even more than in volunteers. Models of drug distribution should include dynamic airway behaviour during respiration.
Regional Assessment of Pulmonary Function using Rapid Dynamic Acquisition of T1-Maps

Johannes F. T. Arnold¹, Florian Fidler¹, Eberhard D. Pracht¹, Tungte Wang¹, Michael Schmidt¹, Peter M. Jakob²
¹University of Wuerzburg, Wuerzburg, Germany

Regional evaluation of pulmonary function is an important diagnostic tool for the indication of localized or diffuse lung diseases. In order to be viable for clinical practice, a technique compatible with a standard proton MRI set-up should be provided. Presented here is a new approach to image regional lung function with oxygen-enhanced MRI using dynamically acquired T1-parameter-maps, which allows an accurate, quantitative and time-resolved assessment of oxygen transfer and therefore lung function.

Gastrointestinal MR: Esophagus and Stomach

Room E Thursday 13:30 - 15:30

Visualization and Evaluation of Esophageal Peristalsis using TrueFISP Cine MR Imaging in Patients with Esophageal Tumor

Takashi Koyama¹, Shigeaki Umeoka¹, Go Watanabe¹, Ari Kobayashi¹, Akira Hiraga¹, Yutaka Shimada¹, Masayuki Imamura¹, Kaori Togashi¹
¹Kyoto University, Kyoto City, Kyoto, Japan

To evaluate esophageal peristalsis in relation with esophageal tumors and symptoms, 13 patients (12 with cancer and one with submucosal leiomyoma) were studied with cine MR imaging obtained with TrueFISP technique. Presence and interruption of peristalsis, interruption of peristalsis, and passage through the tumor were evaluated. Cine MR enabled direct visualization of the esophageal motility, displaying that an interruption of peristalsis with/without intermittent passage. The findings on cine MR showed good correlated with clinical symptoms and surgical findings. Cine MR may become a new tool to evaluate esophageal motilities and disclose physiologic problems of the esophagus.

Normal MR Appearance of Laparoscopic Nissen Fundoplication

James E. Huprich¹, Jeff L. Fidler¹, Claude Deschamps¹, David Stanley²
¹Mayo Clinic Rochester, Rochester, Minnesota, USA; ²GE Medical Systems, Milwaukee, Wisconsin, USA

Laparoscopic Nissen is a common surgical procedure for the treatment of gastroesophageal reflux disease. Complications occur in less than 5% of patients are frequently related to structural failure of the wrap. Endoscopy and barium studies are frequently inconclusive and misleading. We present the MR findings in seven asymptomatic patients with Nissen fundoplications. An intact wrap is characterized by (1) infra-diaphragmatic location of the wrap; (2) absence of stomach/hernia above the wrap and (3) "hot-dog-in-a-bun" appearance of the fundoplication.

Simultaneous Monitoring of Gallbladder and Gastric Emptying by EPI

Lucia Marciani¹, Debbie Bush², Barbara Pick³, Peter Wright¹, Martin Wickham¹, Jeff Wright², Richard Faulks², Annette Fillery-Travis¹, Robin C. Spiller³, Penny A. Gowland³
¹Sir Peter Mansfield Magnetic Resonance Centre, Nottingham, UK; ²QMC Hospital, Nottingham, UK; ³Institute of Food Research, Norwich, UK

Gallbladder and gastric emptying have been investigated simultaneously using gamma scintigraphy and ultrasound techniques to provide an insight into the physiology of their co-ordinated emptying in response to a meal. Recently, MRI has been shown to be able to measure either the emptying of the gallbladder or of the stomach accurately, non-invasively and with high spatial resolution. In this study we aimed to assess for the first time the potential of EPI for the simultaneous assessment of gallbladder and gastric emptying, with a view of developing a simple method that could improve limitations of previous techniques.

Gastrointestinal MR: Small Bowel

Room E Thursday 13:30 - 15:30

Chinese Medicine Magnetite as a Custom-Made MR Negative Oral Contrast Agent

Jeon-hor Chen¹, Wu-Chung Shen¹, Chung-Ming Chen¹
¹China Medical University, Taichung, Taiwan, Taiwan

A custom-made MR oral negative contrast agent was created from traditional Chinese medicine Magnetite. We tested the feasibility of this new agent for signal suppression of upper gastrointestinal tract and its diagnostic value for magnetic resonance cholangiopancreatography (MRCP) and imaging of stomach tumor. We collected 24 patients who came for MR imaging of upper abdomen. Both pre- and post-orally-enhanced images were acquired with different pulse sequences. The results showed this custom-made agent aided in delineation of stomach mucosa and increased the visualization of CBD and pancreatic duct. It has high potential role for clinical usage.
Frank Pilleul1, Claire Godefroy1, Delphine Yzebe1, Alain Lachaux1, Pierre-Jean Valette1
1Hôpital Edouard Herriot, Lyon, France

Especially in patients with inflammatory bowel disease, MRI seems to be the imaging method of first choice because it offers the advantage of a superior depiction of the inflamed bowel wall and the extramural complications without radiation exposure. A prerequisite for adequate image quality is the oral application of contrast medium, which can be administered with different modalities. The concept of magnetic resonance imaging (MRI) using a 5% mannitol solution as an orally applicable intraluminal contrast agent is a meaningful, reproducible, and reliable imaging method for the depiction of the small bowel.

Dosage Optimization of Hydro Solution for Small Bowel Imaging
Waleed Ajaj1, Susanne C. Goehde1, Roya Jeyrani1, Hubert Schneemann1, Stefan G. Ruehm1, Joerg F. Debatin1, Thomas Lauenstein1
1University Hospital Essen, Essen, Germany

We aimed to optimize the application protocol of a hydro solution for small bowel imaging in terms of bowel distension and patient acceptance. Four different quantities between 1500ml and 800ml of a solution containing 2.5% mannitol and 0.2% locust bean gum were tested in 10 volunteers. Coronal TrueFISP data were acquired between 0 and 30 minutes after the contrast ingestion. The use of 1000ml turned out to provide the optimal balance between high bowel loop distension and low-side effects.

MRI of the Small Bowel: Impact of a Rectal Enema Regarding Image Quality
Susanne C. Goehde1, Waleed Ajaj1, Thomas C. Lauenstein1, Roya Jeyrani1, Burcu Narin1, Stefan G. Ruehm1
1University Hospital Essen, Essen, Germany

We aimed to assess the impact of a rectal enema on small bowel distension in patients undergoing small bowel MRI. Two groups consisting of each 20 patients were studied. Group A underwent small bowel MRI after ingesting a contrast solution only. In group B a water rectal enema was additionally administered just prior to MRI. For the quantitative analysis, the bowel was divided into nine segments and mean bowel loop diameters were calculated. Bowel distension in group B was significantly higher for the terminal ileum and all colonic segments. We recommend the administration of rectal water for small bowel imaging.

Digital Subtraction Dark-Lumen MR Colonography for LESION DETECTION – INITIAL EXPERIENCE
Christoph U. Herborn1, Waleed M. Ajaj2, Thomas C. Lauenstein1, Sandra Massing1, Stefan G. Ruehm1
1University Hospital Essen, Essen, Germany

In this study we investigated a digital subtraction technique for dark-lumen MR colonography: A non-enhanced study was subtracted from a gadolinium-enhanced examination in order to facilitate the detection of areas of increased contrast uptake. In 13 patients with suspected colonic lesions dark-lumen MR colonography was performed with endoscopy as the gold standard. Cases were read on two separate occasions: Once without and four weeks hereafter with the subtracted data set. Read-out was significantly shorter with the subtracted images, in addition, a small polyp was detected which was initially overseen. Subtraction is easy to apply and could supplement MR colonography.

MR Colonography Without Bowel Cleansing: Impact of an Oral and Rectal Stool Softener
Waleed Ajaj1, Joerg F. Debatin1, Susanne C. Goehde1, Hubert Schneemann1, Roya Jeyrani1, Stefan G. Ruehm1, Thomas Lauenstein1
1University Hospital Essen, Essen, Germany

Aim of this study was to assess the effect of stool softeners on MR colonography (MRC) without colonic cleansing. 10 volunteers underwent MRC with and without the oral administration of lactulose and a rectal enema consisting of ducosat sodium. Both substances led to a decreasing SNR of feces on T1w data sets. The combination of oral lactulose and rectal ducosat sodium, however turned out to provide lowest SNR values of stool. Thus, feces hardly could be distinguished from the dark rectal enema and assessment of the colonic wall is reliably possible.
13:32  872. MR Colonography for the Detection of Inflammatory Diseases of the Large Bowel
Thomas C. Lauenstein¹, Waleed Ajaj¹, Susanne C. Goehde¹, Christoph U. Herborn⁴, Gerald Holtmann¹, Stefan G. Ruehm¹
¹University Hospital Essen, Essen, Germany

We aimed to evaluate MR colonography (MRC) concerning the qualitative and quantitative assessment of large bowel inflammation. 23 patients with suspected colonic inflammation underwent MRC. Endoscopically obtained histopathology specimen were used as the standard of reference. An inflammation index for different bowel segments was determined based on MR-data including contrast uptake of the bowel wall, bowel wall thickening, presence of mesenteric lymph nodes and loss of haustral folds. This index proved a strong correlation with the endoscopic findings including sensitivity/specificity values of 93%/100%.

13:33  873. Phantom Optimisation for Gas Based Colongraphy
Victoria Jardine¹, Evis Sala¹, Richard Black, Martin Graves, David J. Lomas¹
¹University of Cambridge and Addenbrooke's Hospital, Cambridge, UK

A phantom simulating colon with polypoid lesions was developed to optimise sequences suitable for multi-contrast breath-hold imaging for MR colonography using diet preparation and gaseous distension. Initial results suggest limited detection capability for polyps 5mm or less using fast breath-hold sequences and slice thickness of 6mm, but good results for polyps larger than 5mm.

Shuhei Yamashita¹, Takayuki Masui¹, Motoyuki Katayama¹, Nobuko Yoshizawa¹, Harumi Sakahara²
¹Seirei Hamamatsu General Hospital, Hamamatsu, Shizuoka, Japan; ²Hamamatsu University School of Medicine, Hamamatsu, Shizuoka, Japan

The purpose of this study was to compare the three types of T2-weighted images of rectosigmoid carcinoma with respiratory-triggered fast spin-echo (RTFSE), breath-hold fast-recovery fast spin-echo (BHFRFSE), and breath-hold single-shot fast spin-echo (BHSSFSE) sequences. 39 patients were included. Qualitative and Quantitative evaluations were performed. With BHFRFSE sequence, there were less motion artifacts than with RTFSE sequence and better tumor recognition and overall image quality than with the other two sequences. Thus, we concluded that BHFRFSE sequence might be useful in the depiction of rectosigmoid carcinomas.

13:35  875. How Accurate and Consistent Can We Predict Mesorectal Lymph Node Involvement in Primary Rectal Cancer using New MR Morphological Criteria?
Joo Hee Kim¹, Beets L. Geerard², Myeong-Jin Kim¹, Ki Whang Kim¹, Regina GH Beets-Tan²
¹Yonsei University College of Medicine, Seoul, Republic of Korea; ²Maastricht University Hospital, Maastricht, Netherlands

MRI is currently regarded as an accurate imaging modality in the preoperative evaluation of the circumferential resection margin, which is a major predictor of high risk for local recurrence. However, preoperative detection of the other prognostic factor, the nodal status, is still a problem. MR is limited in differentiating metastatic from benign reactive lymph nodes. Using new criteria of indistinct or spiculated margin and mottled heterogeneity of nodes, high-resolution MRI could provide reliable nodal staging in rectal cancer with accuracy of up to 90% and a very high interobserver agreement when the reading is performed by experienced MR radiologists.

Renal MR Imaging

Room E  Monday 14:00 - 16:00

14:00  876. MRI Assessment of Treatment of Tuberous Sclerosis Kidney with Rapamycin and IFN-g in a Mouse Model
Yanping Sun¹, Karl Schmidt¹, Sameer Doshi¹, Lajjong Lee¹, Paul Sudentas¹, Brian Donohue¹, Kirsten Asrican¹, Aelaf Worku¹, Victoria Walker¹, Nisreen EL Hashemite¹, Alan Lader¹, Hiroaki Onda¹, Hongbing Zhang¹, Mitchell S. Albert¹, Ferenc Jolesz¹, David J. Kwiatkowski¹, Sandra L. Dabora¹
¹Brigham and Women's Hospital, Boston, Massachusetts, USA

Renal disease is an important cause of morbidity in tuberous sclerosis complex (TSC), a mendelian disorder with autosomal dominant inheritance. From the recent molecular understanding of this disorder, there is now hope that effective treatment can be developed. We have successfully created TSC mouse kidney model. In this study, we used MRI in conjunction with histology to assess whether treatment with a rapamycin analog (CCI-779) or murine IFN-α decreases severity of disease.
**MR Characterization of Mouse Hypertension Model**
Sheelu Varghese¹, Jeeva P. Munasinghe¹, Martin J. Lizak², Liya Shen¹
¹National Institutes of Health, Bethesda, Maryland, USA

MRI was used to track/detect renal changes related to hypertension in a knockout mouse model.

**Renal Hemodynamics and Deoxygenation in Transient Renal Artery Occluded Rats Evaluated with USPIO Perfusion and BOLD Imaging**
Michael Pedersen¹, Vincent Perot¹, Fabrice Basseau¹, Christ Moonen¹, Nicolas Grenier¹
¹Université Bordeaux 2, Bordeaux, France

This study investigated, in the ipsilateral and contralateral transient renal artery occluded rat kidneys, the cortical and medullary deoxygenation level (R2*), mean transit time (MTT), relative renal blood volume (RBV) and relative renal blood flow (RBF). The former was conducted using T2*-weighted double-echo GE sequences and the latter using the deconvolution approach in addition to the central volume principle following bolus administration of USPIO (Sinerem®). This study demonstrated that MRI revealed a considerable difference in the renal tissue deoxygenation level and renal hemodynamic parameters of blood.

**Quantitative Regional Glomerular Filtration Rate Measured from Dynamic T1-Weighted Bolus Tracking**
Michael Pedersen¹, Jan Markenborg¹, Finn Tågehøj Jensen¹, Hans Stødkilde-Jørgensen¹, Jens Christian Djurhuus², Jørgen Frøkiær²
¹MR Research Center, Aarhus, Denmark; ²Institute of Experimental Clinical Research, Aarhus, Denmark

The aim of this study was to implement a novel mathematical approach to quantify regional (parenchymal) GFR using Gd-DTPA enhanced MRI in healthy pigs. Pixel-by-pixel GFR was calculated with two different algorithms: 1) nonparametric deconvolution, and 2) the Patlak-Rutland-plot approach. These results were compared with simultaneous measurements of whole-kidney GFR using the plasma clearance of 99mTc-DTPA. Findings demonstrated that the mean renal parenchymal GFR did not differ significantly between the nonparametric deconvolution and the Patlak-Rutland-plot approach, whereas the reference GFR values was in general larger than those calculated by MRI.

**The Influence of Blood Perfusion on Apparent Diffusion Coefficient of Normal Renal Tissues: Evaluation with a SE-EPI DWI Sequence with Multiple b Values**
Zhenghan Yang¹, Fei Sun², Cheng Zhou¹, Min Chen¹, Guozhen Li¹
¹Beijing Hospital, Beijing, People's Republic of China; ²GE Medical System, Beijing, People's Republic of China

The aim of this study is to investigate how blood perfusion will influence the apparent diffusion coefficient (ADC) of the normal renal tissues and how to erase this influence. Diffusion-weighted imaging (DWI) with multiple b values was performed in 27 healthy volunteers. On DWI with small b values, the signal reduction of the tissues was markedly influenced by blood perfusion, and the renal tissue got incredibly high ADCs. On DWI with reasonable b values (b1 = 200 sec / mm², b2 = 1000 sec / mm²), however, the influence of blood perfusion on ADCs was almost erased.

**Comprehensive Morphologic and Functional MR Assessment of Kidneys and Urinary Tract in Clinical Routine using a Novel MRI System with 32 Independent Receiver Channels and iPAT**
Heinz-Peter W. Schlemmer¹, Niels Oesingmann¹, Klaus Kueper¹, Katrin Tomaschko¹, Arnulf Stenzl¹, Claus D. Claussen¹
¹University Hospital Tuebingen, Tuebingen, Germany; ²Siemens Medical Solutions, Erlangen, Germany

Renal dysfunction is caused by a variety of congenital and acquired abnormalities. To identify the underlying disease comprehensive morphologic information about the kidneys and entire urinary tract as well as functional information about renal perfusion and function is necessary. Subject of this work is to evaluate the clinical utility of a novel 1.5T whole-body MR scanner (MAGNETOM Avanto, Siemens, Erlangen, Germany) equipped with 32 independent receiver channels. Using the advanced coil technology and iPAT comprehensive MR assessment of kidneys and urinary tract is feasible in clinical routine with high spatial resolution and less than 1 hour examination time.
Using MR BOLD to Assess Rejection in Kidney Transplants
Elizabeth A. Sadowski¹, Sean Fain¹, Becker Bryan¹, Micheal Hofmann¹, Arjang Djamali¹, Thomas Grist¹, M. Christopher Macatol¹
¹University of Wisconsin Madison, Madison, Wisconsin, USA

The purpose of our study is to use the Blood Oxygen Level Dependent gradient echo sequences (BOLD) in assessing the oxygenation status of renal transplants and use it to differentiate between normal, acute tubular necrosis (ATN) and rejection. MRI BOLD imaging was performed on subjects with recent renal transplants. The medullary R2* values and medullary to cortical ratios were lower in the rejection group. Decreased R2* values in the medulla of rejecting kidney corresponds to increased oxygen concentration. BOLD MRI may provide a rapid, non-invasive method for assessing renal oxygen status in transplanted kidneys to determine the presence of rejection.

Perfusion Parameters of MR Renography are Associated with Cardiovascular Disease Risk Factors and Clinical Indices of Kidney Function
Stephen J. Gandy¹, Amor Almahri¹, Kris Armoogum¹, Thiru AP Sudarshan¹, Wendy Milne¹, J.G. Houston¹
¹Ninewells Hospital, Tayside University Hospitals NHS Trust, Dundee, Angus, UK

In this study contrast enhanced MR renography (CE-MRR) was used to investigate the association of renal cortical perfusion with cardiovascular disease history, risk factors, and clinical measurements of renal function in patients with renovascular disease (RVD). MR indices of renal cortical perfusion were derived from signal intensity versus time curves, and subsequently correlated with the clinical parameters. Reduced renal cortical perfusion was found to correlate particularly well with history of peripheral vascular disease or aortic aneurysm, and also with elevated creatinine and systolic blood pressure. These results have validated the MR perfusion method in the clinical context of RVD.

Animal Studies of Liver with MR

Room E Tuesday 13:30 - 15:30

Magnetic Resonance Imaging with Mn-DPDP in Cirrhotic Rat Livers
Corinne Planchamp¹, Xavier Montel¹, Marko K. Ivancevic¹, Jean-Paul Vallée¹, François Terrier¹, Catherine M. Pastor¹
¹Geneva University Hospitals, Geneva, Switzerland

To study the effect of cirrhosis on the hepatic transport of Mn-DPDP, livers isolated from healthy and cirrhotic rats with various score of severity were perfused with Mn-DPDP and the MR signal intensity was recorded over time. Histological examination showed an important alteration in liver tissue with the duration of the bile duct ligation-induced cirrhosis. The signal intensity during Mn-DPDP perfusion decreased significantly and progressively according to the severity score of cirrhosis. Thus, MRI with Mn-DPDP injection can be used to evaluate hepatic injury that increased with the duration of bile duct ligation-induced cirrhosis.

How Can Pharmacokinetic Modeling Decompose the Overall MR Signal Intensity Obtained from Gd-BOPTA into Predicted Signal Intensity in both Hepatocytes and Extracellular Space
Corinne Planchamp¹, Marianne Gex-Fabry¹, Luc Balant¹, François Terrier¹, Catherine M. Pastor¹
¹Geneva University Hospitals, Geneva, Switzerland

We developed a pharmacokinetic model to better define the signal intensity (SI) obtained by MRI during perfusion of isolated rat livers with Gd-BOPTA. Control and cirrhotic livers (30-days and 60-days bile duct ligation) were successively perfused with Gd-DTPA, an extracellular contrast agent, and Gd-BOPTA, which enters into hepatocytes. The SI obtained by MRI was recorded over time. Pharmacokinetic modeling permitted to successfully decompose the overall observed SI in predicted SIs in both hepatocytes and extracellular space. SI in hepatocytes significantly decreased in injured hepatocytes compared to healthy hepatocytes.

VEGF Improved Liver Regeneration Monitored by MRI
Hila Harel¹, Eitan Gross¹, Eli Keshet¹, Orit Pappo¹, Eithan Galun¹, Israel Vlodavsky¹, Rinat Abramovich¹
¹Hadassah University Hospital, Jerusalem, Israel; ²Hebrew University, Jerusalem, Israel

The liver is unique in its capability to regenerate. However, in a cirrhotic or transplanted liver the regeneration is incompetent. The aim of this study was to locate a potential factor to improve liver regeneration in mice. Using MRI, we were able to follow liver regeneration and hemodynamical changes non-invasively. VEGF in the transgenic mice contributed immensely to hepatocyte proliferation and liver regeneration, improving perfusion throughout the process. Additionally, liver volume regulation was disrupted and exceeded 100%. MRI not only enabled us to follow this process non-invasively, but also provided information about tissue functionality.
13:33 887. **Gd-BOPTA Transport in Rat Hepatocytes: Uptake and Biliary Excretion are Highly Temperature Dependent**

Corinne Planchamp¹, Gerd J. Beyer¹, Daniel O. Slosman¹, François Terrier¹, Catherine M. Pastor¹
¹Geneva University Hospitals, Geneva, Switzerland

To gain information on the transport regulation of Gd-BOPTA, a hepatobiliary contrast agent, we set up a method to quantify Gd-BOPTA transport using radioactivity measurements and MRI in the isolated perfused rat liver. Gd-BOPTA labeling with ¹⁵³Gd and ¹⁵³Sm is appropriate in contrast to ⁶⁷Ga. Gd-BOPTA uptake into hepatocytes and biliary excretion are highly temperature-dependent. Radiolabeling of contrast agents is accurate and useful to quantify contrast agents and thus to better interpret the changes of SI observed in MRI due to temperature variation.

13:34 888. **Hemodynamics Changes of Liver Cirrhosis Measured by Dynamic Contrast Enhanced MRI using Compartment Modeling Analysis**

Hitoshi Kubo¹, Masafumi Harada¹, Makoto Ishikawa², Hiromu Nishitani¹
¹University of Tokushima, Tokushima, Japan; ²Otsuka Pharmaceutical Co., Ltd. Tokushima Research Institute, Tokushima, Japan

To evaluate hemodynamic changes of liver cirrhosis in the rat, dynamic contrast enhanced MRI was used and compartment modeling analysis was applied for quantitative evaluation. As a result, the increase of K1 and decrease of k2 were shown in liver cirrhosis suggesting the increase of permeability from vessels and the decrease of washout. This may reflect congestion and fibrosis in cirrhotic liver.

**Hepatobiliary MR Imaging**

Room E  Tuesday 13:30 - 15:30

13:30 889. **Quantification of Liver Iron with Rapid 3D R¹ and R₂ Mapping with DESPOT1 and DESPOT2**

Sean CL Deoni¹, James A. Kost¹, Paul A. Adams², Elaine O'Riordan², Brian K. Rutt¹
¹Robarts Research Institute, London, Ontario, Canada; ²London Health Sciences Center, London, Ontario, Canada

Hemochromatosis is an inherited disorder characterized by excessive storage of iron with the liver, heart, pancreas and other abdominal organs. In this study, we investigated the use a new, rapid 3D combined R1 and R2 mapping method as a means of non-invasive liver iron quantification. The method offers rapid acquisition and processing speed, provides 3D coverage of the whole liver and permits collection of both R1 and R2 data in less than 5 minutes with high reproducibility and low variability. Both R1 and R2 show high correlation with liver iron content.

13:31 890. **WITHDRAWN**

13:32 891. **Value of Dual Fast T₁ Weighted Gradient Echo MR Sequences for Quantification of Fat Liver: Compared to Pathologic Results**

Frank Pilleul¹, Géraldine Chave¹, Sophie Desmê¹, Jean-Yves Scoazec¹, Pierre-Jean Valette¹
¹Hôpital Edouard Herriot, Lyon, France; ²Centre Léon Bérard, Lyon, France

Fatty infiltration of the liver is a nonspecific response of the liver tissue to various kinds of injury or systemic disorders. Research on fatty liver has seen a recent rapid growth. Rather than liver biopsy, a reliable non-invasive method would be an improvement. Several studies have indicated that MRI techniques can be used to evaluate the degree of liver steatosis. In the present study, liver steatosis has been evaluated using the chemical shift results between in and out of phase T1 weighted gradient echo compared to quantitative histologic grading score of fat hepatocytes.

13:33 892. **Multi-Echo R₂* Technique in the Quantification of Hepatic Iron**

David Stanley¹, Jeffery Fidler¹, Jason Polzin¹, Ken Hwang¹
¹GE Medical Systems, Milwaukee, Wisconsin, USA; ²Mayo Clinic, Rochester, Minnesota, USA

This project was a feasibility study to evaluate a novel technique to quantify the amount of hepatic iron using R₂* (R2 star). If the iron load is elevated, then the R₂* value will be increased. Subjects were scanned on 1.5T and 3T and the results compared. The long term goal of this study is to evaluate patients with hemochromatosis and compare the needle biopsy results with the R₂* values. It is our opinion that MRI will replace many needle biopsy procedures for the evaluation iron deposition in the hepatic system.

13:34 893. **Liver Iron Measurement and Mapping using MRI**

Paul Clark¹, Wanida Chua-anusorn¹, Timothy St. Pierre¹
¹The University of Western Australia, Perth, Western Australia, Australia

We describe a readily available non-invasive method of measuring and imaging liver iron concentrations in vivo using clinical 1.5 T magnetic resonance imaging units. Mean hepatic proton transverse relaxation rates were measured for 105 human subjects and were highly correlated (r = 0.98) with hepatic iron concentration measured by needle biopsy chemical assay. The method has a range of measurement of hepatic iron concentration from 0.3 to 42.7 mg Fe/g dry liver tissue and is highly reproducible on multiple MRI units. The method thus offers the possibility of readily available non-invasive absolute hepatic iron concentration measurements to the clinical community.
13:35 894. MRI Measurements of Magnetic Susceptibility of the Liver in Normal Subjects

Zili Chu¹, Raja Muthupillai¹, Taylor Chung¹, Zhiyue J. Wang¹
¹Baylor College of Medicine, Houston, Texas, USA; ²Philips Medical Systems, Cleveland, Ohio, USA

Magnetic susceptibility can be used for measuring the liver iron concentration under iron overload. The magnetic susceptibility difference between the liver tissue and venous blood was obtained from 3D gradient echo images acquired with cardiac synchronization and navigator gating and tracking. Six normal subjects were scanned at 1.5T, and two of them received multiple scans. The standard deviation in susceptibility of the two multiply scanned subjects corresponded to 0.06 and 0.02 mg Fe/g wet tissue, respectively. The range of the susceptibility in the 6 subjects corresponded to 0.3 mg Fe/g wet tissue.

13:36 895. Evaluation of Different T2-Weighted Imaging Techniques for Liver MRI

Janio Szklaruk¹, Aparna Balachandran¹, Eric P. Tamm¹, Jingfei Ma¹, Lyle D. Broemeling¹
¹UT M.D. Anderson Cancer Center, Houston, Texas, USA

Our goal is to evaluate the efficacy of four different T2 techniques that are commercially available for liver imaging. We compared the following techniques: FSE (fast spin echo), SSFSE (single shot fast spin echo), fast recovery fast spin echo (FRFSE), and spin echo echo planar imaging (SE-EPI). Our results show that there were no significant difference in lesion detection, CNR, and SNR for malignant lesions between FSE and the SE-EPI and FRFSE. Whereas, the SSFSE is significantly inferior to the other sequences in lesion visualization, CNR, and SNR.

13:37 896. In Vivo Measurement of Hepatic Triglyceride Composition in Murine Non-Alcoholic Steatosis

Ian Corbin¹, Steve Pickup¹, Emma Furth¹, E.J. Delikatny¹
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

In the present study in vivo proton magnetic resonance spectroscopy (MRS) was used to examine hepatic steatosis in the obese/obese mouse. MRS offers the capability of evaluating both the content and composition of intracellular lipid droplets. Localized hepatic MR spectra were acquired with exception resolution which allowed the identification of a number of saturated and unsaturated fatty acid moieties. Indices of fatty acid acyl chain saturation, mean unsaturation and polyunsaturation were determined for hepatic triglycerides non-invasively.

13:38 897. Respiratory Motion Correction for 31P Spectroscopy in the Left Lobe of the Liver

Michael Schür¹, Michael Lesuriel¹, Sebastian Kozerke¹, Pierre-Alain Clavien¹, Peter Boesiger¹
¹University and ETH Zurich, Zurich, Switzerland; ²University Hospital Zurich, Zurich, Switzerland

Phosphorus MR spectroscopy allows to study hepatic metabolism non-invasively. Respiratory motion may degrade the quality of 31P spectra acquired in the left lobe of the liver. Respiratory motion compensation based on cardiac ECG and respiratory navigator double triggering including navigator volume tracking is proposed in this study. Motion correction based on navigator echoes is shown to increase the fitting accuracy in prior knowledge based quantification of 31P liver spectra by about a factor of two compared to non navigated acquisitions.

13:39 898. Segmented-True FISP for Abdominal MR Imaging: Assessment of the Portal Vein, the Hepatic Vein and the Bile Duct

Takashi Ueda¹, Masato Uchikoshi¹, Isumi Imaoka¹, Akihiko Wada¹, Kazuo Iwaya¹, Michimasa Matsuo¹
¹Tenri Hospital, Tenri City Nara, Japan

The purpose of this study was to optimize fat-suppressed (FS) segmented-TrueFISP sequence for imaging of portal veins, hepatic veins, and bile ducts. FS segmented-TrueFISP images were applied to the phantoms of liver parenchyma, saline, and oil, and 5 healthy volunteers with various flip angles and various k-space segmentations. The largest flip angle of 65 degree and 75 segments provided the best contrast between saline, oil, and liver parenchyma phantom. With these optimized parameters, FS segmented-TrueFISP provided the excellent anatomical delineation of portal veins, hepatic veins and bile ducts in our preliminary study.

13:40 899. MRCP, Initial Experience at 3Tesla.

Stephan Schmitz¹, Joanna Allsop¹, Julie Zeka¹, Serena Counsell¹, Christina Malamanteniou¹, Demosthenes Kokkinos¹, David J. Larkman¹, Jo V. Hajnal¹
¹Hammersmith Hospital, Imperial College London, London, UK

Magnetic resonance cholangiopancreatography (MRCP) is an established tool at 1.5 Tesla magnetic field strength. Image quality at 3 Tesla may be superior owing to the higher signal-to-noise ratio at the higher field strength. However, RF inhomogenieties and susceptibility effects from bowel gas may inversely affect image quality. In addition, the specific absorption rate (SAR) limits at 3Tesla may resulting in longer acquisition times, compromising breath-hold. We studied the feasibility of MRCP at 3 Tesla and compared the imaging results with a 1.5 Tesla Scanner and concluded from our initial experience that 3T provides greater diagnostic potential for MRCP.
Value of Half-Fourier FSE with Short ETS and Long TE for Respiratory-Triggered Three-Dimensional MR Cholangiopancreatography (MRCP) using Parallel Imaging for Evaluation of Bile Duct Branching Pattern

Akiyoshi Yamamoto\textsuperscript{1}, Katsumi Nakamura\textsuperscript{1}, Mitsue Miyazaki\textsuperscript{2}, Yuka Matsufuji\textsuperscript{3}

\textsuperscript{1}Tobata Kyoritsu Hospital, Kitakyushu, Fukuoka, Japan; \textsuperscript{2}Toshiba Medical Systems, Otawara, Tochigi, Japan; \textsuperscript{3}Toshiba Medical Systems, Fukuoka, Japan

Three-dimensional MR cholangiopancreatography (MRCP) provides excellent bile duct anatomy with high spatial resolution, however, signals of portal vein sometimes remain significantly, which would interfere the interpretation of biliary tree. Using short ETS in 3D-half-Fourier FSE with parallel imaging permit less blurring and faster acquisition, however they also increase the signals of portal and hepatic vein, which would obscure the bile duct. Long T\textsubscript{eff} of 750msec or more could suppress the signals of blood and the hepatic parenchyma. Therefore, half-Fourier FSE with long TE in combination of short ETS and parallel imaging allows depiction of the bile clearly.

Steady-State Coherent Imaging as a Pitfall-Shooter for MR-Cholangiography

Yuji Watanabe\textsuperscript{1}, Masako Nagayama\textsuperscript{1}, Akira Okamura\textsuperscript{1}, Yoshiki Amano\textsuperscript{1}, Takashi Katsube\textsuperscript{1}, Tsuyoshi Suga\textsuperscript{1}, Shingo Koyama\textsuperscript{1}, Suguru Kakite\textsuperscript{1}, Kohya Nakatani\textsuperscript{1}, Marc Van Cauteren\textsuperscript{2}, Yoshihiro Dodo\textsuperscript{1}

\textsuperscript{1}Kurashiki Central Hospital, Kurashiki, Okayama, Japan; \textsuperscript{2}Philips Medical Systems, Best, DA, Netherlands

Various diagnostic pitfalls in MRCP have been reported to simulate or mask various pathology of the extrahepatic biliary system. Pseudostenosis of extrahepatic bile duct can be caused by pulsatile compression of hepatic arteries. Pseudodefect of the gallbladder and bile duct can be caused by bile flow artifact. In some cases, it may be difficult to differentiate polypoid tumor from a gallstone. Steady-state coherent imaging shows both flowing and static fluid showed high signal intensities, which allows to accurately diagnose diagnostic pitfalls of pseudostenosis and pseudodefect. Steady-state coherent imaging will be a good pitfall-shooter for MR cholangiography.

3T MRI of the Liver. Establishing a Comprehensive Highfield Clinical Imaging Protocol and Comparison to 1.5T

Marcus von Falkenhausen\textsuperscript{1}, Juergen Gieseke\textsuperscript{2}, Nuschin Morakkabati\textsuperscript{1}, Goetz Lutterbey\textsuperscript{1}, Renate Bloehmer\textsuperscript{4}, Christiane K. Kuhl\textsuperscript{1}, Hans H. Schild\textsuperscript{1}

\textsuperscript{1}Radiologische Universitätsklinik Bonn, Bonn, Germany; \textsuperscript{2}Philips Medical Systems, Hamburg, Germany

Up to know there is limited experience with abdominal imaging at 3T due to secerall difficulties coming up with high field imaging like increased artefacts and altered contrast. We established a comprehensiv protcol for 3T imaging and compared this intra-indvidually to 1.5T.

3D Breath-Hold Fat-Suppressed T\textsubscript{1}-Weighted Abdominal MRI at 3.0 Tesla

Houman Mahallati\textsuperscript{1}, Michel Louis Lauzon\textsuperscript{1}, Richard Frayne\textsuperscript{1}

\textsuperscript{1}University of Calgary, Calgary, Alberta, Canada

High quality, 3D fat suppressed T\textsubscript{1} weighted images are a mainstay of abdominal MRI. We have modified the vendor-provided sequence to allow 3.0 Tesla breath-hold 3D T\textsubscript{1} weighted images with excellent suppression of both fat and flow-related signal. We demonstrate that this sequence can be used at 3.0 Tesla with a body coil to obtain multi-phase, post contrast data sets and that the quality of these images is similar to those obtained at 1.5 Tesla using a torso phased array coil.

3T MRI of the Liver after SPIO Application. A Comparison to 1.5T

Marcus von Falkenhausen\textsuperscript{1}, Juergen Gieseke\textsuperscript{2}, Nuschin Morakkabati\textsuperscript{1}, Goetz Lutterbey\textsuperscript{1}, Renate Bloehmer\textsuperscript{4}, Christiane K. Kuhl\textsuperscript{1}, Hans H. Schild\textsuperscript{1}

\textsuperscript{1}Radiologische Universitätsklinik Bonn, Bonn, Germany; \textsuperscript{2}Philips Medical Systems, Hamburg, Germany

At highfield imaging susceptibility effects are pronounced compared to 1.5T. Thus SPIO enhanced liver imaging should lead to a stronger drop in liver parenchyma signal compared to 1.5T, resulting in an increase of contrast between liver and focal liver lesions. This intraindividual comparativ study shows the feasibility of SPIO enhanced liver imaging at 3T. Furthermore there were no relevant differences between 1.5T and 3T with respect to image quality, lesion detectability or image artefacts in 22 patients.

Optimized Dual-Echo T\textsubscript{1}-Weighted Abdominal MRI at 3.0 Tesla

Michel Louis Lauzon\textsuperscript{1}, Houman Mahallati\textsuperscript{1}, Richard Frayne\textsuperscript{1}

\textsuperscript{1}University of Calgary, Calgary, Alberta, Canada

Breath-hold T\textsubscript{1} weighted abdominal MRI at 3.0 Tesla requires short TE times, large flip angles and spatial saturation, all of which lead to timing and/or SAR limitations. We enhanced and optimized a 2D gradient echo sequence by allowing asymmetric dual echoes, constraining the slice-to-slice time based on gradient timings and 10 second average SAR deposition requirements, and adding a “cool down” time after the breath-hold to satisfy 6 minute average SAR requirements. This optimization allows efficient, full-coverage T\textsubscript{1} weighted liver imaging in a breath-hold with high SNR/CNR and minimal risk of slice mis-registration, yet still satisfies all stipulated SAR requirements.
T2-weighted abdominal MRI necessitates extended coverage and is ideally done in a breath-hold, but SAR requirements pose stringent limits on both of these needs. We optimized FSE-derived sequences by constraining the slice-to-slice time based on gradient timings and 10 second average SAR deposition requirements, and added a “cool down” time after the breath-hold to satisfy 6 minute average SAR deposition requirements. This optimization allows efficient, full-coverage T2-weighted liver imaging in a breath-hold with greater resolution and minimal risk of slice mis-registration, yet still satisfies all stipulated SAR requirements.

Resp triggered and breath hold 3D MRCP using 3D FR-FSE with ASSET were compared. Breath hold MRCP provide less SNR even with 8 channel phased array coil. Resp-triggered 3D MRCP using FR-FSE with ASSET can be routinely used in daily clinical settings and image quality of resp triggered MRCP, as an alternate, breath hold 3D MRCP can be used.

Diffusion-weighted single-shot echo-planar imaging with simultaneous use of SENSE (SENSE-DWI) has far superior image quality than the past versions. This method provides new progression in abdominal imaging where DWI has been scarcely indicated. We assessed 40 pathologically proven hepatic metastases using three gradient factors (b = 0, 150 and 500 sec/mm²). The apparent diffusion coefficient, ‘true’ diffusion coefficient and the perfusion fraction of metastases and normal liver were estimated. Colorectal metastases demonstrated a significantly higher ‘true’ diffusion coefficient (D) but lower perfusion fraction (PF) compared with normal liver parenchyma.

Diffusion weighted single shot echo planar imaging with simultaneous use of SENSE (SENSE-DWI) has far superior image quality than the past versions. This method provides new progression in abdominal imaging where DWI has been scarcely indicated. We assessed 40 pathologically proven hepatic metastases using three gradient factors (b = 0, 150 and 500 sec/mm²). The apparent diffusion coefficient, ‘true’ diffusion coefficient and the perfusion fraction of metastases and normal liver were estimated. Colorectal metastases demonstrated a significantly higher ‘true’ diffusion coefficient (D) but lower perfusion fraction (PF) compared with normal liver parenchyma.

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13:53 912. **An Ability of Contrast-Enhanced Gd-EOB-DTPA (SH L 569 B) MR Images for Detecting Hepatocellular Carcinoma in Hepatic Arterial-Dominant Phase: Comparison with Contrast-Enhanced Gd-DTPA MR and CT Images**
Takatoshi Kitamura1, Tomoaki Ichikawa1, Kuni Ohtomo2, Hiroto Nakajima1, Tsutomu Araki1, Nobuyuki Enomoto1, Tatsuki Tsukamoto1, Hironobu Sou1, Utarou Motosugi1, Kazushi Uozumi2
1University of Yamanashi, Nakakoma, Yamanashi, Japan; 2University of Tokyo, Bunkyo, Tokyo, Japan

For hepatic arterial-dominant phase imaging, ability of Gd-EOB-DTPA MR images may be only limited based on our results of detectability of HCC and CNR of the images, which may be caused by insufficient dose (25 Ìmol/kg) of Gd-EOB-DTPA.

13:54 913. **Early Verification of Irradiated Field using Superparamagnetic Iron Oxide (SPIO) Enhanced MR Imaging**
Takayuki Obata1, Hirotoshi Kato1, Naoki Morimoto1, Susumu Kandatsu1, Hiroo Ikehira1, Shuji Tanada1, Hirohiko Tsujii1
1National Institute of Radiological Sciences, Chiba, Japan

Superparamagnetic iron oxide (SPIO) enhanced MR imaging was performed for early verification of localized radiation therapy accuracy. Six patients with hepatocellular carcinoma were examined by a gradient echo pulse sequence (TR, 115 ms; TE, 4.1 ms; Flip angle, 40) immediately after carbon-ion irradiation. The irradiated fields were clearly detected as higher intensity areas, which were visually consistent with the physical dose distribution of the treatment planning. SPIO-enhanced MR imaging may be useful for early verification of treatment planning.

13:55 914. **Determination of Optimal Scan Timing of Contrast-Enhanced Gd-EOB-DTPA (SH L 569 B) MR Images during Hepatobiliary Phase for Detecting Hepatocellular Carcinoma**
Takatoshi Kitamura1, Tomoaki Ichikawa1, Kuni Ohtomo2, Hiroto Nakajima1, Tsutomu Araki1, Nobuyuki Enomoto1, Tatsuki Tsukamoto1, Hironobu Sou1, Utarou Motosugi1, Kazushi Uozumi2
1University of Yamanashi, Nakakoma, Yamanashi, Japan; 2University of Tokyo, Bunkyo, Tokyo, Japan

For the purpose of detecting HCC, optimal scan timing of contrast-enhanced Gd-EOB-DTPA MR images during hepatobiliary phase may be considered at least 10 min based on the results of lesion detectability, and may be recommended 20 min after the beginning of injection of Gd-EOB-DTPA based on the results of SNR and CNR of the images.

13:56 915. **Breath-Hold T2-Weighted MR Imaging of the Liver: Comparison of True FISP, True FISP with Driven Equilibrium Preparation Pulse, and Breath-Hold Fast Spin-Echo With or Without Fat Suppression.**
Yoshimitsu Ohgiya1, Takehiko Gokan1, Toshi Hashimoto1, Hiroshi Nobusawa1, Seishi Matsui1, Masanori Hirose1, Hirotsugu Munechika1
1Showa University School of Medicine, Shinagawa-ku, Tokyo, Japan

Purpose: To evaluate true FISP (tFISP), fat-suppressed true FISP (tFISP-FS), true FISP with driven equilibrium preparation pulse (tFISP-DE), breath-hold fast spin-echo (FSE) and fat-suppressed breath-hold fast spine-echo (FSE-FS) for the detection of focal hepatic lesions and image quality. RESULTS: On the basis of ROC analysis, the detection rates of solid lesions were highest on tFISP-FS. The detection rates of non-solid lesions were highest on FSE-FS. CONCLUSIONS: Fat-suppressed true FISP and true FISP with driven equilibrium preparation pulse provide good image quality and are useful in the detection of solid tumors in the liver.

Shahid M. Hussain1, Jan De Becker2, Soendersing Dwarkasing1, Piotr A. Wielopolski1
1Erasmus MC, Rotterdam, Netherlands; 2Philips Medical Systems, Best, Netherlands

A black-blood T2-weighted spin-echo echo planar imaging sequence with sensitivity encoding is feasible in patients with the signal-to-noise ratio of the liver comparable to the standard respiratory-triggered T2-weighted turbo spin-echo sequence.

13:58 917. **Abdominal Three Point Dixon Imaging with Self Calibrating Parallel MRI**
Charles A. McKenzie1, Scott B. Reeder2, Ann Shimakawa1, Norbert J. Pelc2, Jean Brittain1
1Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; 2Stanford University Medical Center, Stanford, California, USA

This work evaluates the feasibility of using self calibrated parallel MRI to accelerate abdominal three point Dixon imaging. Self calibrating parallel imaging was used to avoid artifacts in the parallel imaging reconstruction that can occur when sensitivity calibration is acquired separate from accelerated data. In vivo fat/water separated images were reconstructed from accelerated and fully gradient encoded FSE Dixon data. Parallel imaging reduced the acquisition time, while the high SNR efficiency of the Dixon reconstruction offset parallel imaging induced SNR losses. The fully gradient encoded and accelerated fat/water images were of similar quality.
**Poster Sessions**

13:59 **918. Opposed-Phase MR Imaging with FIESTA or True FISP Sequence in the Upper Abdomen:**
Comparison with Opposed-Phase GRE T1WI
Zhenghan Yang¹, Cheng Zhou¹, Min Chen¹, Guozhen Li¹
¹Beijing Hospital, Beijing, People's Republic of China

The purpose of this study is to investigate the usefulness of opposed-phase True FISP/FIESTA sequence in the detection and characterization of focal lesions containing fat in the upper abdomen. In-phase GRE T1WI, opposed-phase GRE T1WI, and True FISP/FIESTA opposed-phase images were performed in 54 patients with various upper abdominal lesions containing fat. Our results indicate that compared with opposed-phase spoiled GRE T1WI, opposed-phase True FISP/FIESTA sequence can provide similar or more effective information in the detection and characterization of lesions containing fat in the upper abdomen.

14:00 **919. Efficacy of Single Breath-Hold Digital Subtraction with Multi-Arterioportal MR Images in Hepatocellular Carcinoma.**
Katsumi Sasaki¹, Katsuyoshi Ito¹, Takeshi Fujita¹, Ayame Shimizu¹, Toshinobu Tsukuda¹,
 Minoru Hayashida¹, Naofumi Matsunaga¹
¹Yamaguchi University of Medicine, Ube, Yamaguchi, Japan

We tried to determine visibility of hepatocellular carcinoma with single breath-hold digital subtraction of multi-arterioportal MR images. We obtained MR arterial perfusion images by subtracting first phase images from third phase images and MR portal perfusion images by subtracting third phases from sixth phase. We compared arterial phase (third phase) images and portal phase (sixth phase) images to MR arterial and portal perfusion images. MR arterial perfusion images were statistically significant higher lesion-to-liver contrast ratio than other images. This study suggests that MR arterial perfusion images were effective in detecting of hepatocellular carcinoma.

14:01 **920. Negative Contrast Agents for MRCP: In-Vitro and In-Vivo Evaluation of Beverages Popular in South East Asia.**
Angeline, C C Poh¹, Wilfred C G Peh¹, Helmut Rumpel²
¹Changi General Hospital, Singapore, Singapore; ²Singapore General Hospital, Singapore, Singapore

In-vitro experiments were conducted on 10 different beverages to determine those with T1 relaxation times suitable as oral negative contrast agents for nulling the bowel signal during MRCP. Pre- and postcontrast MRCP scans were obtained in 10 volunteers each consuming 4 shortlisted drinks on 4 different occasions. Pre- and postcontrast MRCP scans for different beverages were compared. The visualization of the biliary anatomy was moderately improved using pineapple juice and fresh soyabean milk and markedly improved using Ovaltine and tea. Tea, Ovaltine, soyabean milk and pineapple juice are cheap and effective oral gastrointestinal negative contrast agents in MRCP.

Abdominal MR Spectroscopy

Room E  Wednesday 13:30 - 15:30

13:30 **921. Proton MR Spectroscopy in Fatty Liver: Single Volume Spectroscopy versus Chemical Shift Imaging**
Fan Mingxia¹
¹Radiology, Shanghai, People's Republic of China

Proton MR Spectroscopy has been applied to the evaluation of fatty liver, but few comparisons has been made between different clinical spectroscopic techniques. Using similar parameters for spectral acquisition and consistent positioning of the volume of interest (VOI), we compared the semiquantitative data of methylene (-CH2) groups of triglycerides of rat fatty liver obtained by SE sequence, STEAM sequence of SVS and Chemical Shift Imaging. Our preliminary studies indicate that proton MR Spectroscopy using the technique of CSI is better than SVS to detect and quantify fatty infiltration in liver.

13:31 **922. In Vivo Proton MR Spectroscopic Evaluation of Hepatocellular Carcinoma, Metastasis and Hemangioma in the Liver**
Yuhshi Araki², Yasuyuki Yamashita², Tomohiro Namimoto¹
¹Minamata City General Hospital & Medical Center, Minamata, Kumamoto, Japan; ²Kumamoto University School of Medicine, Kumamoto, Japan

The purpose of this study was to evaluate the in vivo proton (1H) magnetic resonance (MR) spectroscopic features and relative metabolite-to-lipid ratios of phosphomonoester (PME) of hepatic tumor. Thirty-eight patients with liver masses (25 HCCs, 5 metastasis and 8 hemangiomas) were examined with 1H MR spectroscopy. Each liver mass was calculated relative metabolite-to-lipid ratios of PME. The calculated mean value relative metabolite-to-lipid ratios were lower in the hemangioma group than in the hepatocellular carcinoma (HCC) and metastasis group (p<0.05). In vivo 1H MR spectroscopy is able to assess human hepatic tumor.
In vivo $^1$H and $^{13}$C NMR spectroscopy and stable-isotope-dilution technique were applied to assess hepatic glucose metabolism under hyperinsulinemic-hyperglycemic conditions (HI-HG) and its association with hepatic fat accumulation in type 2 diabetic patients (T2DM) and healthy volunteers. Whole body glucose uptake (GU), net hepatic glycogen synthesis (VSynNet) and suppression of endogenous glucose production during HI-HG were 30-50% lower in hyperglycemic conditions (HI-HG) and its association with hepatic lipid accumulation in type 2 diabetic patients (T2DM) and healthy volunteers. Whole body lactate were observed. 1H MR MR spectroscopy of the rat testis was considered as promising tool for evaluating testicular function in vivo.

Clinical use of liver spectroscopy requires a simple, clinically feasible method including a stable protocol for the acquisition of the spectra and a reliable quantitative analysis. We will introduce a protocol for acquisition of liver spectra with a transmit/receive body coil at 3T as well as a semi-quantitative analysis to estimate concentration ratios of lipids and choline containing compounds.

In vivo $^1$H MR spectroscopy of the rat testis at 4.7T is demonstrated. Since the entire region of the obtained spectrum was contaminated with large lipid resonances, resonances from minor metabolites were obscured. To suppress lipid resonances, short TI inversion-recovery (STIR) was successfully utilized at STEAM sequence. As a result, high resolution $^1$H MR spectra including resonances from creatine, choline, glycine, glutamate, and lactate were observed. $^1$H MR spectroscopy of the rat testis was considered as promising tool for evaluating testicular function in vivo.

Characterization and pre-operative staging are important for correct management of patients with ovarian tumours. Our study was to determine if proton MR spectroscopy could improve the specificity of conventional MRI. 31 patients with suspected ovarian pathology were studied. 2-D chemical shift imaging (CSI) with echo time either 70ms or 144ms was performed. Choline was detected in patients with malignancy greater than FIGO stage 1. Presence of choline was 100% specific for malignancy. The signal from choline was not significantly different between the two echo times. N-acetyl peaks detected in mucinous ovarian tumours, has not been reported previously.

MR Imaging of Congenital Vaginal Anomalies

Vaginal anomaly is an uncommon but important gynecologic problem needed treatment. The goals of treatment are to establish a vagina capable of sexual function, to prevent endometriosis, and to preserve fertility. Proper surgical management of these anomalies depends on the presence of absence of cervix and functioning endometrium[1,2]. Ultrasound has been used in this regard, but it can be inconclusive[3]. Magnetic resonance (MR) imaging has become a reliable means of imaging of genital tract[4]. In this work the correlation between MR imaging and operative findings in nine patients with vaginal anomalies and the role of MR imaging in preoperative assessment are examined.
13:31  **929. Development of Magnetic Resonance Hysterosalpingography for Assessment of Infertility**  
Nandita M. deSouza1, Ruth Williamson1, Amanda Stonebridge-Foster2, Rebecca A. Quest1, Stuart A. Lavery1, Anne P. Hemingway1  
1Hammersmith Hospitals NHS Trust, London, UK

This study describes the technical development of Magnetic Resonance Hysterosalpingography (MR-HSG) as an adjunct to conventional MR imaging of the pelvis. In 3 patients with infertility a dynamic series of scans was obtained using a T1-W fat-suppressed 3-D acquisition before and serially after injection of 5ml of a 1 in 50 dilution of gadobenate dimeglumine into the uterine cavity. Maximum Intensity Projections of the subtracted images were used to delineate the uterine cavity and fallopian tubes. MR-HSG is safe and well-tolerated, contributing further information on tubal patency, cavity anomalies and endometrial adhesions in < 5 mins of additional scan time.

13:32  **930. Altered Adipose Tissue Deposition after Extremely Preterm Birth**  
Sabita Uthaya1, E Louise Thomas1, Gavin Hamilton1, Neena Modi1, Jimmy D. Bell1  
1Hammersmith Hospital, Imperial College London, London, UK

Adipose tissue compartments have been shown to have differential metabolic functions, with intra-abdominal adiposity showing a high association with insulin resistance. Yet little is known as to the factors that determines adipose tissue distribution. We have used MRI to assess depot specific body fat in preterm babies in order to explore the possible determinants of adipose tissue deposition. Results show that preterm birth alters the trajectory of adipose tissue deposition in comparison with term-born babies, with preferential distribution of adipose tissue in the intra-abdominal compartment

13:33  **931. Fetal MRI: SSFSE versus FIESTA**  
Hiroshi Shinmoto1, Yutaka Tanami1, Koichi Oshio1, Akihiro Tanimoto1, Nobuya Higuchi1, Shigeo Okuda1, Sachio Kuribayashi1  
1Keio University School of Medicine, Tokyo, Japan

This study compares single shot fast spin echo sequence (SSFSE, GE) with fast imaging employing steady-state sequence (FIESTA, GE) in depiction of fetal anatomical details, including brain, chest, liver, gastrointestinal tract and musculoskeletal system. For the brain, both sequences provide comparable image quality. SSFSE is superior to FIESTA in evaluating demarcation of the lung and differentiation of the small intestine and the colon. In contrast, FIESTA is superior to SSFSE in evaluating the intrahepatic vascular structures and musculoskeletal structure. Theses two sequences should be adapted to suit the occasion for fetal pathology.

13:34  **932. 3T High-field MRI with Ultra-High Spatial Resolution**  
Nuschin Morakkabati-Spitz1, Juergen Gieseke2, Christiane Katharina Kuhl1, Goetz Lutterbey1, Markus von Falkenhausen1, Hans Heinz Schild1  
1University of Bonn, Bonn, Germany; 2Philips Medizin Systeme, Hamburg, Germany

The purpose of this study was to develop a 3T pulse sequence with ultra-high spatial resolution in acceptable acquisition time. Concerning delineation of small anatomic details, the 3T high spatial resolution protocol was highly superior to 1.5T. The quantitative analysis revealed a tendency towards reduced image contrast at 3T. In summary, high spatial resolution pelvic studies with high image quality can be obtained on a 3 Tesla system in an acceptable scan time. If this also translates into more clinically relevant diagnostic information remains to be seen, and is subject to an ongoing study.

13:35  **933. Endometrial Carcinoma - Comparison of Preoperative MRI and Postoperative Pathologic Findings**  
Monika Bekiesinska-Figatowska1, Jerzy Walecki1, Alicja Ceran1, Mariusz Bidzinski1, Grzegorz Panek1  
1Central Railway Hospital, Warsaw, Poland; 2Central Hospital of Ministry of Internal Affairs, Warsaw, Poland; 1Institute of Mother's and Child's Health, Warsaw, Poland, 2Institute of Oncology, Warsaw, Poland

79 women with clinical stage I endometrial carcinoma underwent MRI. The depth of invasion, tumor volume and lymph node involvement were assessed and compared to post-surgery findings. In 5 cases clinical stage I was excluded, stage II was diagnosed. Stage IA was found in 17 women, IB – 37, IC – 20. Enlarged lymph nodes were shown in 10. The disease was overestimated in 5 patients, underestimated in 1. The staging accuracy of MRI was 93.6%. In 2 cases additional ovarian malignancy was diagnosed. MRI allows precise staging of endometrial carcinoma, necessary to plan the extent of surgery.

13:36  **934. True FISP: Is It Really T2 Like Contrast? : Comparison with Turbo SE Images in Ovarian Pathology**  
Masaaki Hori1, Tomoaki Ichikawa1, Katsuhiro Sano1, Tsutomu Araki1, Kazunori Kasai2, Masato Ashizawa2, Kazuhiko Kuvamoto2  
1University of Yamanashi, Nakakoma, Yamanashi, Japan; 2Yamanashi Prefectural Central Hospital, Kofu, Yamanashi, Japan

Purpose of this study was to compare signal pattern of True FISP with that of T2-weighted TSE in several ovarian pathology and to clarify what pathology may be misdiagnosed when True FISP was used as a fast T2-weighted MR imaging technique. Hemorrhagic changes or fatty component in the lesions, the ovarian lesions often showed contrary signal patterns between the two sequences. 30% of signal patterns between the two sequences in ovarian pathology were contrary. Although True FISP has the advantage of short acquisition times, the sequence is not be able to replace T2 weighted TSE in evaluation of ovarian pathology.
MR of Prostate

Room E  Monday 14:00 - 16:00

14:00  935. Therapy Monitoring of the Prostate with MRI by Assessment of the Volume and of Substructures within the Gland

Hans Polzer\(^1\), Hannes Henry\(^1\), Johannes T. Heverhagen\(^1\), Klaus T. Baudendistel\(^1\), Guang Jia\(^1\), Hendrik von Tengg-Kobligk\(^2\), Hee Chun\(^1\), Thomas J. Rosol\(^1\), Michael V. Knopp\(^1\)

\(^1\)The Ohio State University, Columbus, Ohio, USA; \(^2\)German Cancer Research Center (DKFZ), Heidelberg, Germany

Purpose of this study was to monitor prostate volume under therapy using MRI and to observe changes in different regions and tissues of the gland. 12 beagles with spontaneous BPH were divided into a treatment (Finasteride) group and a control group. All dogs were imaged five times (week -3, 0, 4, 8, 12). 3 different volumes were assessed, total, periurethral and glandular (=total- periurethral) volume. The glandular area showed severe, the total volume intermediate and the periurethral region the least relative decrease in volume. MRI is capable to quantify different substructures within the gland, and therefore is an excellent tool to monitor treatment effects.

14:01  936. Evaluation of Benign Prostatic Hyperplasia Treatment Response using Dynamic Contrast-Enhanced MRI

Hannes Henry\(^1\), Hans Polzer\(^1\), Johannes T. Heverhagen\(^1\), Klaus T. Baudendistel\(^1\), Guang Jia\(^1\), Hee Chun\(^1\), Hendrik von Tengg-Kobligk\(^2\), Xiangyu Yang\(^1\), Andrea L. Levine\(^1\), Thomas J. Rosol\(^1\), Michael V. Knopp\(^1\)

\(^1\)The Ohio State University, Columbus, Ohio, USA; \(^2\)German Cancer Research Center (DKFZ), Heidelberg, Germany

Purpose of this study was to demonstrate changes in the prostate of beagles during treatment of BPH using DCE-MRI. Pharmacological effects were revealed by changes of contrast enhancement characteristics. During treatment with finasteride the parenchymal zone shrinks and the intensity of contrast enhancement increases which reflects an increase in blood volume per unit of tissue. The time to maximum signal intensity is prolonged in the parenchymal zone which demonstrates a longer accumulation period of the contrast agent in the tissue. We conclude that DCE-MRI is capable to characterize benign tissue changes in the prostate and to monitor effects of treatment.

Cancer MR in the Body

Room E  Monday 14:00 - 16:00

14:00  937. Diffusion-Weighted MR Imaging in the Evaluation of the Seminal Vesicle Invasion of the Prostate Adenocarcinoma

Xiao Ying Wang\(^1\), Jian Ping Ding\(^1\), Liang Ping Zhou\(^1\), Xue Xiang Jiang\(^1\)

\(^1\)Peking University First Hospital, BeiJing, People's Republic of China

To evaluate whether ADC can be used to differentiate seminal vesicle invasion of the prostate adenocarcinoma from post hormone deprivation changes. DWI (b=1000sec/mm\(^2\)) was performed with a 1.5T MR unit in 40 patients. The mean ADC of seminal vesicles invaded by prostate adenocarcinoma, (0.30±0.08 [mean±SD] \(^{*}\)10-3mm\(^2\)/sec (n=8), was significantly smaller (P<0.001) than that of seminal vesicles after hormone deprivation therapies, (0.56±0.17)*10-3mm\(^2\)/sec (n=8). As conclusion, measurement of ADCs may be used to characterize seminal vesicle lesions.

14:01  938. Diffusion-Weighted MR Imaging of Seminal Vesicle and Prostate Gland in Normal Volunteers

Xiao Ying Wang\(^1\), Jian Ping Ding\(^1\), Xue Xiang Jiang\(^1\)

\(^1\)Peking University First Hospital, BeiJing, People's Republic of China

To evaluate whether there was any difference between the ADCs of prostate and seminal vesicle calculated from DWI using different b values. EPI diffusion study was performed with four b values(300, 600, 800, 1000s/mm\(^2\)) in 15 volunteers. ADCs of seminal vesicle and prostate gland measured with different sequence were different depending on the different b values. Higher b values is recommended to be used to obtain higher contrast of ADC values between the peripheral zone and central zone of the prostate gland.

14:02  939. Diffusion Tensor MR Imaging of the Prostate Adenocarcinoma

Xiao Ying Wang\(^1\), Jian Ping Ding\(^1\), Liang Ping Zhou\(^1\), Xue Xiang Jiang\(^1\)

\(^1\)Peking University First Hospital, BeiJing, People's Republic of China

EPI DTI (b=1000s/mm\(^2\), direction=13) was performed with a 1.5T MR unit in 16 healthy male volunteers and 28 PCA patients. The mean ADC of PCa foci (0.45±0.16 [mean±SD] \(^{*}\)10-3mm\(^2\)/sec (n=24), was significantly smaller (P<0.001) than that of normal peripheral zone of the prostate (1.43±0.27)*10-3mm\(^2\)/sec (n=14). The mean FA of PCa foci (0.67±0.09) (n=24), was significantly greater (P<0.001) than that of normal peripheral zone of the prostate (0.37±0.08) (n=14). As conclusion, the ADC and FA values may be used to differentiate the prostate adenocarcinoma from the normal prostate peripheral zone.
14:03 940. **3D MRSI Evaluation of Local Recurrence of Prostatic Cancer in Men Who Have Undergone Radical Prostatectomy**  
Xiaoying Wang, Jian Ping Ding, Liang Ping Zhou, Xue Xiang Jiang  
1Peking University First Hospital, Bei Jing, People's Republic of China

To evaluate the ability of 3D MRSI in evaluation of local recurrence of malignancy in men who have had radical prostatectomy for prostatic adenocarcinoma. Considering the biopsy as golden standard, the sensitivity of 3D MRSI in revealing local recurrence of prostatic cancer was 85.7% (12/14), the specificity was 76.9% (10/13), the accuracy was 81.5% (22/27). The MRS appearance of high choline peak had positive predictive value of 80% (12/15). The high lipid peak in the spectrum reduced the sensitivity of MRS results.

14:04 941. **Metabolic Effects of Prostate Cancer after Brachytherapy as Measured by Three Dimensional Magnetic Resonance Spectroscopic Imaging**  
Xiao Ying Wang, Jian Ping Ding, Liang Ping Zhou, Xue Xiang Jiang  
1Peking University First Hospital, Bei Jing, People's Republic of China

To investigate the metabolic effects of prostate after brachytherapy in the patients with prostate cancer with 3D MRSI. After brachytherapy, the choline, creatine, and citrate levels decreased. Citrate levels decreased more prominently than choline and creatine levels ($\chi^2 = 7.86, P<0.01$). In long-term treated group, the metabolic atrophy areas of choline, creatine and citrate was significant more than that of short-term group and untreated group ($\chi^2 = 6.62, P<0.05$). In long-term treated patients, for PSA normal patients the metabolic atrophy areas of choline, creatine and citrate was significant more than that of PSA abnormal patients ($\chi^2 = 13.01, P<0.01$).

14:05 942. **Prostate MRI and MRS at 3T: Using Phased Surface Coil Array**  
Hui Mao, Xiongping Hu, Keith Heberlein, Robert Smith, William Torres  
1Emory University School of Medicine, Atlanta, Georgia, USA

Conventional prostate MRI and MRS is done using endorectal probe at 1.5T. To improve this method, we used receiving-only phased surface coil array for prostate MRI and MRS at 3T. We report that phased array MRI at 3T has significantly improved imaging quality in FOV, spatial resolution and tissue contrast. 3T phased array prostate MRS is feasible using single voxel technique. Signal and quality of the spectrum can be improved after combining signals from multiple coil elements. Choline, creatine and citrate are well resolved. It suggested that clinical application of 3T phased array prostate MRI and MRS is possible.

14:06 943. **Tumour-Laden Prostates NOT Detected by MRSI**  
Lawrence Ryner, Len LeBoldus, Abdualatif Hussain, Ian C. P. Smith, Tedros Bezabeh  
1National Research Council Canada, Winnipe, Manitoba, Canada; 2Health Sciences Centre, Winnipeg, Manitoba, Canada

The use of MRSI to detect malignancies of the prostate has been well reported. It is clear that the ratio of choline:creatin to citrate is a useful diagnostic marker for malignancy. However, full evaluation of sensitivity and specificity of this marker at different clinical sites has not yet been reported. There have been some reports in the literature showing that this technique is not 100% sensitive and specific. However, with relatively few negative reports, we report here our initial experience on MRSI findings that did not concur with histopathology on radical prostatectomy patients.

14:07 944. **Citrate Magnetic Resonance Spectroscopy at 3 T**  
Dong-Hyun Kim, Dirk Mayer, Sandeep Hunjan, Lei Xing, Daniel Spielman  
1Stanford University, Stanford, California, USA

Citrate is an important metabolite in aiding detection of prostate cancer. Previously, 1.5T protocols have been well established. With the inherent increase in signal to noise ratio at 3T, various different extensions of Citrate detection can be accomplished. In this abstract, we investigate the different spectral patterns of Citrate for changing echo times and radio frequency inhomogeneities. Due to its strong coupling effects, different patterns arise for the Citrate resonance at 3T.

14:08 945. **The Clinical Value of Diffusion Weighted Image for Prostate Cancer at 3 Tesla**  
Hiroshi Fukatsu, Shinji Nagayawa, Takeo Ishigaki  
1Nagoya University School of Medicine, Nagoya-city, Aichi, Japan

The clinical value of Diffusion Weighted MRI for prostate cancer was examined with 14 pathologically proved cases. A 3 Tesla whole body MRI with 8-channel body array coil was used. DWI of 5 or 6 mm slices thickness with single shot EPI sequence with b-factor of 600 was compared with standard transaxial 3mm-thick T2WI. Blinded reading test revealed that ADC map could detect 12 out of 16 cancer foci prospectively while T2WI could detect only 7 foci. At 3 Tesla, ADC map for prostate cancer should be a reliable tool for prostate cancer detection.
14:09  **946. Diffusion Weighted Imaging of the Prostate Gland in the Face of Magnetic Susceptibility Differences – Parallel EPI and PROPELLER FSE Approaches**  
*Timothy P.L. Roberts¹, Masoom Haider³*  
¹University of Toronto, Toronto, Ontario, Canada

A thorough tissue characterization of prostate cancer includes the investigation of diffusion weighted imaging as an indicator of tumor cellularity. However, the anatomic location of the prostate imposes magnetic field inhomogeneity arising from magnetic susceptibility differences at bowel air: tissue interfaces. To address this parallel imaging with sensitivity encoding is explored as a means of reducing TE and thus sensitivity to such inhomogeneity. Further the recently developed PROPELLER FSE sequence is investigated as an alternative, insensitive to magnetic field variation. Adult male healthy volunteers were studied using each pulse sequence approach and images were judged based on artifact and blur.

**MR in Adiposity**

Room E  
Monday 14:00 - 16:00

14:00  **947. In Vivo Measurement of Body Composition Using Proton Magnetic Resonance Spectroscopy**  
*Yanping Luo¹, Vince Hradil¹, Kurt Mohning¹, Nayereh Ghoreishi-Haack¹, Robin Shapiro¹, Victoria Knourek-Segel¹, Robert Dickinson¹, Eugene Bush¹, Michael Brune¹, Peer Jacobson¹, Bryan Cox¹*  
¹Abbott Laboratories, Abbott Park, Illinois, USA

In vivo quantification of body composition is important for studying metabolic disorders. By quantifying water and lipid resonances, proton MRS offers a highly sensitive, quantitative measure of body water and lipids. This abstract describes a validation study for using proton MRS to quantify fat content and demonstrates the usefulness of such measurement for monitoring changes in body fat content in a rat model of obesity.

14:01  **948. Control of Adiposity by Environment Enrichment**  
*Po-Wah So¹, Phillip Muckett¹, Amy H. Herlihy¹, Jimmy D. Bell¹*  
¹Hammersmith Hospital, Imperial College London, London, UK

Environmental enrichment is of increasing importance in terms of welfare in biological research. One such environmental enrichment method is the inclusion of running wheels in the cage. The impact of the availability of running wheels on the adiposity and bodyweights of C57BL/6 mice was investigated in a long-term serial study. Our results show that body adiposity but not bodyweights is significantly modulated by the voluntary use of running wheels under laboratory conditions. Further studies are on the way to assess the impact of similar environmental enrichment protocols on body function in various models of disease.

14:02  **949. Modulation of Adipose Tissue Content and Composition by Omega-3-Fatty Acids in a Murine Model of Obesity**  
*Po-Wah So¹, Anna Furmanski¹, Amy H. Herlihy¹, Jimmy D. Bell¹*  
¹Hammersmith Hospital, Imperial College London, London, UK

Dietary omega-3 fatty acids have been shown to exert influences at cellular and organ level, in some cases leading to a significant modulation of adipose tissue content and distribution. In this study we have investigated the effects of omega-3-fatty acids on adipose tissue content and metabolism in the ob/ob(-/-) mice and its lean control counterparts. We have shown that ob/ob(-/-) mice, a murine model of obesity, appears to be differentially influenced by an increase in omega-3 fatty acids in the diet, compared to control and that the modulation of adipose tissue by omega-3 fatty acids may be model specific.

**Interventional MR**

Room E  
Tuesday 13:30 - 15:30

13:30  **950. Navigation with Hall Sensor Device for Interventional MRI**  
*Klaus Scheffler¹, Jan G. Korvink²*  
¹University of Basel, Switzerland; ²IMTEK, Freiburg, Germany

Active tracking and navigation of interventional devices is essential for MRI-guided interventions. Active determination of the spatial position of the device can be used for automatic slice positioning without the need of additional user interaction. Here we present the design and construction of a prototype Hall sensor device, which detects its location and orientation by measuring the local magnetic field, generated by magnetic field gradients of the running sequence.
Conclusion: The combination of a closed bore MR with an AR system provides a very intuitive and accurate method for needle biopsy. Placed inside the lesions with a distance to the center below 2 mm. In the animal all punctures were successful with a needle deviation of less than 5 mm. Ranging 6-12 mm diameter were performed. The AR-system was then used in vivo in one pig. Result: In all experiments the biopsy needle tip was correctly determined with high accuracy. The technique was tested with an optical navigation system installed close to the MR-system. The overall accuracy errors in a clinical work situation. For this purpose, a combination of active MR and optical markers were used. An improved MR-localization technique determines positions with high accuracy. The technique was tested with an optical navigation system installed close to the MR-system. The overall accuracy of the automatic registration was in the sub-millimeter range, as required in neurosurgical applications.

New approaches to peak detection and data combination based on Bayesian statistic are explored in order to improve MR tracking reliability in anticipation of in-vivo intravascular human trials. Data quality measures are introduced, both for use by the tracking system and to guide the user. The presented methods provide good standard deviation estimates for high SNRs and Signal-to-Interference-Ratios (SIRs), and conservative estimates at lower SNRs and SIRs, and unbiased expectations for all SNRs and SIRs. Since many of the steps are achieved using analytical expressions, an algorithmic complexity sufficiently low for real-time processing is achieved.

A small solenoidal coil with a length to diameter ratio = 3:1 can be used to give an accurate measurement of the angle between the coil and the direction of B0 (linear over a limited range) due to the cosine dependence of the frequency shift generated by the field from the coil. Angular measurement was achieved using a single spectroscopic pulse-acquire sequence without applied gradients. The angular measurement was approximately independent of position within the uniform field volume due to the high magnet uniformity. A sensitivity of 0.13 ppm/degree was obtained using a current of 100 mA.

New approaches to peak detection and data combination based on Bayesian statistic are explored in order to improve MR tracking reliability in anticipation of in-vivo intravascular human trials. Data quality measures are introduced, both for use by the tracking system and to guide the user. The presented methods provide good standard deviation estimates for high SNRs and Signal-to-Interference-Ratios (SIRs), and conservative estimates at lower SNRs and SIRs, and unbiased expectations for all SNRs and SIRs. Since many of the steps are achieved using analytical expressions, an algorithmic complexity sufficiently low for real-time processing is achieved.

Rapid Angular Measurement using MAMBA

Arya Nabavi3
Reserve University - University Hospitals, Cleveland, Ohio, USA
1Siemens Medical Solutions, Erlangen, Germany; 2Siemens Corporate Research, Inc, Princeton, New Jersey, USA; 3Case Western Reserve University - University Hospitals, Cleveland, Ohio, USA

Bayesian MR Tracking Algorithms

Patrick Gross1, Robert D. Darrow1, Charles L. Dumoulin1
1GE GRC, Schenectady, New York, USA

Application of k-t BLAST to Passive Catheter Tracking: Initial Evaluation In-Vivo

Holger Eggers1, Jeffrey Tsao2, Steffen Weiss1, Arno Buecker1, Marcus Kato1, Klaus P. Frueßmann1, Peter Boesiger2
1Philips Research Laboratories, Hamburg, Germany; 2University and ETH Zurich, Zurich, Switzerland; 1University Clinic Aachen, Aachen, Germany

k-t BLAST is a method to accelerate dynamic imaging by exploiting spatiotemporal correlations. In this work, it was applied to the monitoring of catheters in a pig's aorta. Cartesian and radial acquisitions were employed for imaging, into which the measurement of training data, as required by k-t BLAST, was incorporated. The reconstruction with k-t BLAST was carried out off-line, while an adapted sliding window reconstruction was performed on-line. Images obtained with both approaches were compared, showing a considerable gain in temporal resolution and a reduced motion blurring and subsampling artifacts with k-t BLAST, particularly for the Cartesian acquisitions.

Automatic Registration of an Optical Navigation System with an MR System using Active Markers with High Accuracy

Tobias Schaeffler2, Arno Schmitgen1, Christoph Leussler1, Martin Budhath1, Maximilian Mehdorn1, Arya Nabavi1
1Philips Research, Hamburg, Germany; 2Localite GmbH, Bonn, Germany; 3University Clinic, Kiel, Germany

We have developed a technique to register MR-image data with an optical navigation system without any user-interaction and thus reducing potential user-errors in a clinical work situation. For this purpose, a combination of active MR and optical markers were used. An improved MR-localization technique determines positions with high accuracy. The technique was tested with an optical navigation system installed close to the MR-system. The overall accuracy of the automatic registration was in the sub-millimeter range, as required in neurosurgical applications.

Local-Look HASTE MRI with Interactive Slice Positioning for an Active Needle System

Hendrik Zimmermann1, Sven Zuehlsdorff1, Steffen Volz2, Reiner Unathum1, Wolfhard Semmler1, Michael Bock1
1Deutsches Krebsforschungszentrum, Heidelberg, Germany

A prototype needle holder with three micro-coils for localisation is used in combination with a dedicated user interface for interactive scan plane orientation. A Local-Look HASTE pulse sequence is implemented to image the needle pathway at a highly reduced phase field-of-view without backfolding and with minimised susceptibility artefacts. Both slice orientation and different image contrasts can be controlled easily and monitored by the interventionalist from an in-room-monitor using the interface.

MR Imaging-Guided Needle Biopsies with an Augmented Reality System in a Closed Bore System: A Pilot Study Assessing the Feasibility in Phantoms and a Pig

Frank K. Wacker1, Sebastian Vogt2, Ali Khamene1, Frank Sauer2, Jeffrey L. Duerk1, Jonathan Levin1
1Siemens Medical Solutions, Erlangen, Germany; 2Siemens Corporate Research, Inc, Princeton, New Jersey, USA; 1Case Western Reserve University - University Hospitals, Cleveland, Ohio, USA

Purpose: To test the feasibility of biopsies performed with a MR-image based augmented reality (AR) navigation system. Method: 24 biopsies with targets ranging 6-12 mm diameter were performed. The AR-system was then used in-vivo in one pig. Result: In all experiments the biopsy needle tip was correctly placed inside the lesions with a distance to the center below 2 mm. In the animal all punctures were successful with a needle deviation of less than 5 mm.

Conclusion: The combination of a closed bore MR with an AR systems provides a very intuitive and accurate method for needle biopsy.
13:37 957. MR Respiratory Motion Tracking For Use With an Augmented Reality Surgical System
Daniel Robert Elgort1, Frank K. Wacker2, Sebastian Vogt2, Ali Khamene2, Frank Sauer2, Jonathan S. Lewin1, Jeffrey L. Duerk1
1Case Western Reserve University, Cleveland, Ohio, USA; 2University Hospitals of Cleveland, Cleveland, Ohio, USA; 3Siemens Corporate Research, Princeton, New Jersey, USA

Augmented reality (AR) surgical systems allow image-guided interventions to take place outside of the MR scanner. The AR system used here incorporates image data and additional real-time information directly into the surgical environment via 3D overlays mapped onto the patient and surgical equipment. A significant technical challenge presented by AR surgical systems is compensating for organ/target motion due to respiration. This study presents a solution to this problem by using real-time active MR tracking to capture the motion of the chest wall during respiration. The motion of the chest wall is then correlated to the motion of abdominal organs.

13:38 958. Respiratory Motion Correction for Subtraction Images during Passive Endovascular Device Tracking
Lambertus W. Bartels1, Remko van der Weide1, Jan-Henry Seppenwoolde1, Chris J.G. Bakker1
1University Medical Center Utrecht, Utrecht, Netherlands

In susceptibility-based passive device tracking, subtraction of a reference image without markers in it from thick-slab tracking images has been shown to be a valuable tool for increasing marker visibility. However, subtraction and overlay techniques are very sensitive to motion. In the abdomen, the major source of tissue motion is respiration. Making use of SENSE, the frame rate achievable allows the acquisition of multiple images during one respiratory cycle. We propose a technique to compensate for respiratory motion by automatically finding the best of a series of reference images for subtraction during dynamic scanning. In vivo results are presented.

13:40 959. A Novel Background Suppression Method for Endovascular Therapy
Nirupama Nagarajappa1, Mohammad Sabati1, M Louis Lauzon2, Richard Frayne1
1University of Calgary, Calgary, Alberta, Canada; 2Calgary Health Region, Calgary, Alberta, Canada

We propose a novel background suppression method using Hadamard (HD) RF pulses for better background suppression and improve the visualization of contrast-filled catheters. We hypothesized that since tissue is locally homogeneous over a certain extent, HD RF slice profiles will provide optimum suppression of heterogeneous background tissue. A simple heterogeneous tissue model was developed to compare HD RF profiles with the more commonly used projection dephaser (PD) methods. From our simulations, HD RF pulses provide improved catheter-to-background signal difference and catheter contrast compared to conventional PD methods.

Steffen Volz1, Sven Zuehlsdorff1, Christian Fink1, Peter Hallscheidt1, Wolfhard Semmler1, Michael Bock1
1DKFZ, Heidelberg, Germany; 2University of Heidelberg, Heidelberg, Germany

Flow measurements with catheter coils have been shown to be capable of automated real-time velocity quantification of blood flow. The averaging effect over the sensitivity profile was simulated by calculating the magnetic field of the coils and the MR-Signal including the sequence parameters and the velocity field around the catheter. The simulations showed a position-dependent scaling factor which is practically independent on the velocity itself. This scaling factor was applied for a correction of measurements in the aorta of small pigs.

13:42 961. MR-Guided Percutaneous Sclerotherapy of Low-Flow Vascular Malformations: Qualitative and Quantitative Assessment of Therapy and Outcome
Daniel T. Boll1, Elmar M. Merkle1, Jonathan S. Lewin1
1University Hospitals of Cleveland, Cleveland, Ohio, USA

To evaluate therapy and outcome of percutaneous MR-guided sclerotherapy in low-flow vascular malformations in the head & neck, paraspinal region and extremities. Seventy-six percutaneous sclerotherapy procedures were successfully performed without complications. The actual interventional took 31:50±14 min, induced vascular thrombosis was identified in all treated portions and significant shrinkage of the low-flow vascular malformations was observed.

Clifford Raabe Weiss1, Parag Karmarkar1, Aravind Arepally1, Ergin Atalar1
1Johns Hopkins University, School of Medicine, Baltimore, Maryland, USA

Cirrhosis and portal hypertension is a significant worldwide healthcare burden. Classically the portal venous system has been decompressed using either the surgical meso-caval shunt or a fluoroscopically guided transjugular intrahepatic portosystemic shunt (TIPS) procedure. Both procedures carry inherent risks. Using only MR guidance and a novel MR intravascular needle system we were repeatedly able to successfully puncture the superior mesenteric vein from the inferior vena cava in a highly controlled manner with direct visualization of all components, thus performing the first step in the development of a hybrid new decompression procedure – the MR guided meso-caval shunt.
13:43 963. **Percutaneous MRI Guided Mitral Annuloplasty: Preliminary Results**
Parag Karmarkar1, Amish N. Raval2, Ranil de Silva2, Cengizhan Ozturk2, Ronnier J. Aviles2, Michael Guttman2, Elliot R. McVeigh2, Ergin Atalar1, Robert J. Lederman2
1Johns Hopkins University, Baltimore, Maryland, USA; 2National Institutes of Health, Bethesda, Maryland, USA

We have developed an MRI active mitral annular restrictive device to be implanted in the coronary sinus to treat ischemic mitral dilatation. The device is tested in a porcine model demonstrating the feasibility of performing MR guided percutaneous mitral annuloplasty.

Maythem Saeed1, Christine Henk1, Oliver M. Weber1, Alastair J. Martin1, Mark Wilson1, Kendrick Shunk1, David Saloner1, Charles B. Higgins1
1University of California San Francisco, San Francisco, California, USA

Combined x-ray angiography/MR imaging (XMR, Philips Med. System) was used for assessment of acute aortic coarctation and deployment of stents in dogs. The following MR sequences were used: T1-FFE sequence for measurement of aortic flow, T1-FFE sequence for MRA and B-FFE sequence for MR fluoroscopy. Aortic blood flow was reduced after coarctation from 1.3±4.8 to 0.2 L/min. Deployment of nitinol stent (12-14mm) increased aortic flow to 0.8±0.1 L/min. The imaging modalities showed the changes in flow direction and volume after coarctation and repair. Thus, combination of x-ray angiography/MR imaging may be necessary in stent patency assessment.

13:45 965. **Three-Dimensional MR Projection Imaging of the Coronary Arteries Following Catheter-Directed Injection of Contrast Agent**
Jordin D. Green1, Reed A. Omary1, Brian E. Schirf1, Richard Tang1, James C. Carr1, Debiao Li1
1Northwestern University, Chicago, Illinois, USA

The feasibility of performing real-time visualization of coronary arteries after intra-arterial (IA) contrast injection with thick-slice 2D projection imaging has been recently demonstrated. Further improvements in vessel contrast-to-noise ratio (CNR) are necessary to allow safe and accurate MRI-guided interventions. This study demonstrates that IA 3D projection imaging permits high quality coronary MRA, and that it significantly improves CNR over 2D projection imaging (p < 0.05).

Brian Schirf1, Jordin Green1, Richard Tang1, Kent Sato1, Ali Shaibani1, James Carr1, Debiao Li1, Reed Omary1
1Northwestern University, Chicago, Illinois, USA

Catheter based coronary MRA was performed in six swine using electrocardiographically-triggered, magnetization prepared, 2D projection True-FISP. Following MRI-guided coronary catheterization, intra-arterial (IA) injections of contrast agent were performed. Dilute injections of 8% gadolinium demonstrated a significantly greater signal-to-noise-ratio (SNR) than 4% (p = 0.05). Compared with the tested contrast concentrations, 8% gadolinium would maintain SNR and limit the total contrast agent dose in MRI-guided endovascular procedures using True-FISP.

13:47 967. **Comparison of Gradient Echo and Spin Echo Sequences in Interventional MR Imaging: Is There a Single Optimal Sequence for All Purposes?**
Daniel T. Boll1, Jonathan S. Lewin1, Jeffrey L. Duerk1, Elmar M. Merkle1
1University Hospitals of Cleveland, Cleveland, Ohio, USA

Four pulse sequences suitable for interventional MR imaging were compared during biopsies in the head and neck as well as abdominal imaging. Evaluation focused on Contrast to Noise Ratio, vessel conspicuity, and diagnostic quality. A clear relationship between the sequence selection and the anatomical region of the MR – guided procedure was detected. Image guidance during liver procedures was best achieved by PSIF or turbo spin echo T2w imaging, whereas biopsies in the head and neck were best performed utilizing FISP or True – FISP sequences.

13:48 968. **Development of an 0.014-in Magnetic Resonance Imaging-Guidewire**
Bensheng Qiu1, Perry Karmarkar1, Fabao Gao1, Chris Brushett1, Ryan Kon1, Sourav Kar1, Ergin Atalar1, Xiaoming Yang1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

We have developed an 0.014-inch diameter magnetic resonance imaging guidewire (MRIG) by plating or cladding high electrical conductive materials, silver and gold, over the flexible, nonmagnetic biocompatible, alloy conductors. This new MRIG was designed to offer both mechanical property of the MRIG for intravascular MR-guided interventions and the reduced electrical attenuation of RF transmission along the MRIG for high-resolution MR imaging.
13:50 970. **Trans-Esophageal Cardiac MRI: Initial Clinical Experience**  
Justin D. Pearlman¹, Ling Gao¹, Lawrence A. Minkoff²  
¹Dartmouth Medical School, Hanover, New Hampshire, USA; ²Magna-Lab, Inc, Syosset, New York, USA

Transesophageal MRI (TEMRI) consists of two perpendicular deformable loop antennas in quadrature, measuring 120x80mm inside a small balloon that anchors position behind the heart in the esophagus, plus a focused surface coil. This system was applied in 15 subjects. TEMRI provided higher CNR (3.5±0.64) vs. body coil (2.1±0.98), p<0.0001. The effective FOV was smaller by a factor of 2.31±0.98. The reduced number of phase-encoding lines can be converted to over-sampling within an equal acquisition time, to improve contrast:noise further. Targets seen better by TEMRI include the aortic and pulmonary valves and the proximal coronary arteries.

13:51 971. **Permanent Magnet Shimming for the X-Ray Detector in a Hybrid X-Ray/MR System**  
Zhifei Wen¹, Rebecca Fahrig², Norbert J. Pelc²  
¹Stanford University, Stanford, California, USA

In our x-ray/MR hybrid system, a flat panel detector is placed under the patient cradle close to the MR volume of interest (VOI), where the magnetic field strength is ~0.5T. Ferromagnetic components inside the detector create an additional magnetic field that is superimposed on the original field of the scanner. Even after linear shimming the field homogeneity is still degraded by the ferromagnetic components in the detector. We propose using permanent magnets with optimized strengths and positions to compensate for the second and higher order components of the additional field. Preliminary results showed great promise for this technique.

13:52 972. **Integration of a 6MeV Electron Beam LINAC with a 1.5 T MRI Scanner**  
Bruce E. Hammer¹, Nelson L. Christensen², William King¹, Mark J. Conroy¹, Nate Pogue²  
¹University of Minnesota, Minneapolis, Minnesota, USA; ²Carleton College, Northfield, Minnesota, USA

The spatial distribution of a linear accelerator (LINAC) electron beam within an aqueous solution was quantified in situ by H-1 magnetic resonance imaging (MRI). A 6 MeV electron beam was fired into a ferrous solution located at the center of a 1.5 Tesla MRI magnet. Spin-spin (T2) and spin-lattice (T1) weighted images showed the e-beam trajectory within the aqueous phantom. Oxidation of Fe(II) to Fe(III) by the e-beam yielded a sufficient change in proton relaxation to yield beam path images. Incorporating a radiation delivery system in an MRI scanner lays the foundation for a new generation of medical instrumentation.

**Thermotherapy Assessment**

Room E  Wednesday 13:30 - 15:30

13:30 973. **Monopolar Radiofrequency Thermo Ablation under Real-Time MR Temperature Imaging**  
Bruno Quesson¹, Matthieu Lepetit-Coiffé², Marko Krešimir Ivančević³, Erik Dumont⁴, Christ Moonen⁵  
¹Image Guided Therapy SA, Pessac, France; ²Laboratoire IMS, Bordeaux, France; ³Geneva University Hospital, Geneva, Switzerland

Quantitative temperature imaging is of great interest for Radiofrequency thermoablation. This study presents a home made filtering device for a commercially available RF generator and an internally cooled monopolar electrode. Quantitative MR temperature maps obtained on a 1.5 T clinical scanner depicted no noticeable artefacts for output power up to 80W. Different heating protocols were applied on ex vivo liver samples, varying RF output power and electrode cooling. Necrosis maps were derived from real-time MR temperature images to estimate induced lesion size. They were found to be larger in the presence of electrode cooling, allowing application of higher RF power.

13:31 974. **Measurement of Thermal Diffusivity by Magnetic Resonance Imaging**  
David H. Gultekin¹, John C. Gore²  
¹Yale University, New Haven, Connecticut, USA; ²Vanderbilt University, Nashville, Tennessee, USA

MR thermometry has potential use for monitoring temperature changes during thermotherapy. A method for monitoring diffusion of thermal energy could improve the precision and effectiveness of treatments. A method based on measuring magnetization has been developed for measuring thermal diffusion with potential applications in MR thermotherapy. In this method a thermal pulse is applied to a medium and the resultant temporal variation of nuclear magnetization produced by the thermal pulse is monitored at spatial distances. The resultant temporal variation of magnetization is a characteristic of the substance and from this the thermal diffusivity of the substance can be determined experimentally.
Planning Radiofrequency Ablation of Renal Tumors: Predicting Response from Standard Pre-Ablation MRI Scans

Sherif Gamal Nour1, John R. Jesberger1, Elmar M. Merkle2, Shervin Rafie1, Jeffrey L. Duerk1, Jonathan S. Lewin1
1University Hospitals of Cleveland / Case Western Reserve University, Cleveland, Ohio, USA; 2Duke University Medical Center, Durham, North Carolina, USA

We sought to determine whether information obtained from reviewing standard pre-ablation MRI scans would help predict detailed courses of renal tumor ablation procedures. Correlation coefficients were calculated between tumor parameters (volume and enhancement criteria) and ablation parameters (impedance, current, energy, and ablation time). Number of ablations cycles and electrode positioning were recorded. Special attention was made to any pattern related to particular tumor cell-type. Tumor volume as measured on pre-ablation MRI significantly correlated with total energy required for complete ablation regardless the tumor cell-type. Intra-procedural MRI remains, however, the mainstay to monitor the progress of each individual ablation procedure.

MR-Thermometry Controlled Bipolar RF Tissue Ablation

Marko K. Ivancevic1, Bruno Quesson1, André Roggan1, Matthieu Lepetit-Coiffé1, Sylvain Terraz1, Christoph Becker1, François Terrier1
1Geneva University Hospital, Geneva, Switzerland; 2Image Guided Therapy SA, Pessac, France; 3Celon AG, Berlin, Germany
4Université Bordeaux 2, Bordeaux, France

Radio-frequency ablation is widely used for liver tumor treatment. It is mostly performed using monopolar RF systems under CT or US guidance, due to RF-MR incompatibility. Simultaneous MR imaging is of great interest for MR-thermometry lesion monitoring during ablation. Here we present the feasibility of MRI temperature control of RF lesion in an ex-vivo porcine liver model, using a mono-probe bipolar ablation system, with appropriate RF filtering. The methodology presented shows important potential for better RF tissue ablation control, and opens possibilities for optimizing the efficiency of hyperthermia protocols for a wide range of RF ablation systems.

Corrections and Calibration of MR Thermography for Hyperthermia Monitoring in the Hyperthermia/MR Hybrid System

Waldemar Wlodarczyk1, Johanna Gellermann1, Hagen Rehbein1, Jacek Nadobny1, Peter Wust1
1Charité Medical School, Berlin, Germany

Simultaneous temperature monitoring of hyperthermia in the hyperthermia/MR hybrid system is hampered by specific artifacts due to B0 drifts and conductivity changes. After correction of these errors, the accuracy better than 0.5 C was achieved for the temperature monitoring of hyperthermia in the hyperthermia/MR hybrid system in a large phantom and poorly perfused tissue.

Fast Adaptive Control for MRI-Guided Ultrasound Hyperthermia Treatment for Prostate Disease: In Vitro and In Vivo Results

Lei Sun1, Christopher M. Collins2, Michael B. Smith1, Nadine B. Smith1
1The Pennsylvania State University, University Park, Pennsylvania, USA; 2The Pennsylvania State University College of Medicine, Hershey, Pennsylvania, USA

Using the proton resonance frequency shift, ultrasound hyperthermia temperatures can be tightly adjusted using a robust adaptive feedback controller. In vitro and in vivo experimental results demonstrate the capability for closed loop MR temperature control.

Paramagnetic Liposomes as Thermosensitive Probes for MRI Guided Thermal Ablation. Experience and In Vivo Results

Lars Frich1, Atle Bjornerud1, Sigrid Fossheim1, Terje Tillung1, Ivar Gladhaug1
1The Norwegian Cancer Society, Oslo, Norway; 2Rikshospitalet University Hospital, Oslo, Norway; 3Amerham Health, Oslo, Norway

Temperature sensitive liposomal MRI contrast agents constitute a novel approach for thermal dosimetry. The feasibility of using thermosensitive liposomes for thermal imaging in conjunction with MRI guided laser- and radiofrequency ablation of liver was examined using a temperature-sensitive contrast agent with a transition temperature of 57°C. Laser- and radiofrequency ablation was performed in eight rabbit livers in-vivo in a 0.5 T vertically open whole body MR system. For lesions made after administration of the contrast media, a delayed and non-reversible effect was observed where the signal intensity of treated areas was significantly increased after normalization of the tissue temperature.

Optimizing Spatial Resolution for MR Thermal Imaging of Transurethral Ultrasound Prostate Ablation

Laura Jean Pisani1, Anthony B. Ross2, Chris J. Diederich1, William H. Nau2, Gary H. Glover1, F. Graham Sommer1, Kim Butts1
1Stanford University, Stanford, California, USA; 2University of California, San Francisco, San Francisco, California, USA

An approach is described for determining optimal pixel sizes for quantitative magnetic resonance thermal imaging using the proton resonance frequency shift method. Temperature distributions of two transurethral high-intensity ultrasound applicators were simulated and measured in vivo in a canine prostate. The measured temperature distributions agreed well with simulated temperature distributions, and established the signal to noise ratio (SNR) range of interest. When noise is added to simulated temperature distributions for tubular and planar applicators, pixel sizes of 1.7 mm and 1.2 mm, respectively, minimize the average root mean squared differences over the range of SNR levels.
13:38  981.  MR Monitoring of Temperature and Microcirculatory Parameters in Patients with Sarcoma in Hyperthermia/MR Hybrid System

Waldemar Wlodarczyk1, Marek Zwick1, Johanna Gellermann1, Jacek Nadobny1, Peter Wust1
1Charite Medical School, Berlin, Germany; 2Technical University, Berlin, Germany

Besides the temperature the microcirculatory parameters of perfusion, vascularization and extravasation in three patients with sarcoma were monitored before, under and after hyperthermia (HT) therapy in the HT/MR hybrid system. For the first time, a large vascular steal effect and a drastically increased extravasation under HT as well as a significant drop of the tumor vascularization as a therapy effect after HT were demonstrated in patients. The vascular steal effect shows a pronounced switch-on behavior at the first HT fraction changing only gradually during the following fractions whereas the strongest extravasation occurs only under the 1st HT fraction.


Yoshimasa Kurumi1, Shigeyuki Naka1, Shigehiro Morikawa1, Koichirou Sato1, Kouichi Demura1, Tsuyoshi Yamaguchi1, Yoshihiro Endo1, Kazuyoshi Hanasawa1, Tohru Tani1, Toshiroh Inubushi1, Hasnine A. Haque1
1Shiga University of Medical Science, Otsu, Shiga, Japan

130 patients with hepatic tumor were already treated by microwave ablation surgery. The patients consisted of 57 cases of primary hepatic cancer and 73 cases of metastatic hepatic tumor. The recurrence ratio of primary hepatic tumor was about 6.7%. We have clinically applied interactive MR image navigation system to microwave ablation therapy of hepatic tumor, in order to decrease the local recurrent ratio of the treated hepatic tumor.

13:40  983.  TmDOTMA: A Sensitive MR Thermometry Probe for In Vivo Applications

Shahryar K. Hekmatyar1, Andriy Babsky1, Sait K. Pakin1, Navin Bansal1
1Indiana University, Indianapolis, Indiana, USA

MR thermometry techniques based on H-1 water signal suffer from poor thermal resolution. We have investigated the use of paramagnetic lanthanide complexes of DOTMA- for MR thermometry. Among all the lanthanide (Pr(III), Yb(III), Tb(III), Dy(III) and Tm(III)) complexes studied, TmDOTMA- has the most favorable characteristics for MR thermometry. 1H chemical shift of methyl resonance from TmDOTMA- is highly sensitive to temperature but insensitive to pH, Ca2+ or presence of plasma macromolecules and ions. Application of TmDOTMA- for measurement of temperature in a mouse tumor is demonstrated. Overall, TmDOTMA- appears to be a promising probe for MR thermometry in vivo.

13:41  984.  Controlled RF Hyperthermia using TmDOTA as a MR Thermometer

Navin Bansal1, Shahryar K. Hekmatyar1, Sait K. Pakin1, Andriy Babsky1
1Indiana University, Indianapolis, Indiana, USA

Hyperthermia has been shown to be an effective adjuvant therapy for cancer. We present a robust MR technique to deliver controlled HT to subcutaneously (sc) implanted tumors using the MR spectrometer. The method uses the same RF system to deliver HT as used for MR data collection. The temperature is monitored from the H-1 chemical shift of a paramagnetic lanthanide complex, TmDOTMA-, which is 100-times more sensitive to temperature than water H-1 signal. A real-time feedback method is used to ‘lock’ the temperature during RF heating. Application of the technique to a sc implanted mouse tumor is present

13:42  985.  Real-Time MRI-Guided Microwave Surgery of Hepatocellular Carcinoma

Shigeyuki Naka1, Yoshimasa Kurumi1, Koichi Demura1, Koichirou Sato1, Tsuyoshi Yamaguchi1, Hisanori Shiom1, Yoshihiro Endo1, Kazuyoshi Hanasawa1, Tohru Tani1, Shigehiro Morikawa1, Toshiroh Inubushi1, Hasnine A. Haque1
1Shiga University of Medical Science, Otsu, Shiga, Japan; 2GE Yokogawa Medical Systems, Hino, Tokyo, Japan

From January 2000 to September 2002, 57 nodules of hepatocellular carcinoma (HCC) in 45 patients were treated by MRI-guided microwave surgery. The microwave surgery for HCC was performed under real-time MR image guidance with a vertically oriented open MRI system (0.5T SIGNA SP/i system : GE Medical Systems). The microwave electrode and tumor were clearly visualized in the liver during MRI-guided microwave surgery. There were no significant complications and adverse effects. The recurrence lesions at treated site appeared in only 7 cases. Our results suggest MRI-guided microwave surgery is a safe and effective treatment for HCC.

13:43  986.  Importance of Post-Treatment Delay for the Evaluation of the Response to MRIGFUS

Abdeslem Khiat1, David Gianfelice1, Mourad Amara1, Assia Belblidia1, Yvan Boulanger1
1Hôpital Saint-Luc du CHUM, Montréal, PQ, Canada

The response to MR imaging-guided focused ultrasound surgery (MRIGFUS) of breast carcinoma can be assessed noninvasively using dynamic contrast enhanced MRI (DCE-MRI). A good correlation between DCE-MRI parameters and the percentage of residual tumor determined by histopathology was obtained for 21 patients but the correlation was improved when only patients whose DCE-MRI evaluation was performed more than seven days after treatment were considered (17 patients), showing the importance of the interval between treatment and evaluation. Short term post-treatment effects such as inflammation and edema are believed to be responsible for these observations.
MR guided Focused Ultrasound Surgery (MRgFUS) can potentially treat a large population of patients with symptomatic uterine fibroids. This study demonstrates linear correlation between the area of the acoustic window (defined as the area of the abdominal wall through which the MRgFUS beam must avoid critical structures) and the post-treatment volume of nonenhancement (an imaging endpoint of the MRgFUS). We conclude that pre-treatment acoustic window assessment will help identify those patients who may benefit most from MRgFUS. The acoustic window area may be increased with the use of an additional gel pad spacer, and should be considered in selected cases.

MR-guided focused ultrasound with continuous sonication along a spiral trajectory of the focal point has the advantage to deliver a uniform thermal dose within the treated volume. The question of the thermal safety in neighbouring tissue behind and in front of the focal point is addressed here. In-vivo experiments were performed on twelve rabbits. Elliptical regions of different size and aspect ratio were treated under automatic temperature control based on real-time PRF MR-thermometry. Post-treatment MR-follow-up data (Gd enhanced images) confirmed the theoretical prediction. The lesion size and shape were predictable and reproducible.

RF ablation is a clinically proven procedure for minimally invasive therapy. Since MRI can monitor thermal changes, it would be ideal if it could also monitor RF ablation current pathways. We present our first images of the current density patterns created by a clinical RF ablation electrode in a pork sample using prepolarized MRI at 1.1 MHz. We then present the hardware modifications needed to perform a similar imaging protocol on a GE Signa SP 0.5T open MRI scanner. The possibility exists to use 21.3MHz RF current images to predict the ablation pathways even though the system frequencies differ.

Solid tumors are being treated using radiofrequency ablation under interventional MRI guidance. We are investigating the ability of MR to monitor ablation treatments by comparing MR images of thermal lesions to histologically assayed cellular damage. An open MRI system was used to guide an ablation probe into the thigh muscle of rabbits and acquire MR volumes post ablation. After MR and histology images were aligned using a 3D registration, we determined that the region of cell death closely corresponds to the outer boundary of the hyperintense region in T2-weighted MR at 45 minutes and 4 days post-ablation.

fMRI Imaging Techniques

Room F  Monday 14:00 - 16:00

A breathing (BH) task was compared with a sensorimotor (SM) task for calibration of fMRI in the FIRST BIRN 11-center schizophrenia project. Five volunteers were scanned on 2 successive days at all sites with 4 SM and 2 BH scans each day. SM and BH BOLD signal levels in activated voxels averaged across sessions and subjects were found to be correlated at R2 = 0.50, 0.62 and 0.48 in auditory, motor and visual regions, respectively. These results suggest that BH, which measures global vascular reserve devoid of neuronal processing, may be an effective method of calibrating fMRI for multicenter trials.
For longitudinal fMRI studies, it is important to periodically monitor scanner performance to assure that stability, geometric accuracy, signal to noise ratio (SNR) and other characteristics remain consistent over the course of the study. Constancy is even more important when data from multiple scanners are being compared or combined, both initially and over extended periods of time, such as in the FIRST BIRN (fBIRN) project. QA methods developed and used at our site were adapted for the 11-site fBIRN project. Measurements of scanner stability and SNR demonstrate significant variations across the member sites.

We examine the reliability of a transverse relaxometry technique that uses spin echo Echo-Planar Imaging (SE-EPI) with progressively stepped TE values to measure T2*-like values. We compare the T2 values obtained in variously sized phantoms and in regions of the brain that were measured with spin echo, turbo/fast spin echo, TE stepped EPI and segmented TE-stepped EPI techniques. These measurements are performed at 1.5T and at 3.0T. We find that the T2 values measured by spin echo, TE-stepped SE-EPI, and segmented TE-stepped SE-EPI methods show acceptable repeatability, while turbo/fast spin echo results may lack acceptable repeatability for large etl scans.

Correcting the magnetic field distortion in the inferior frontal cortex (IFC) is essential to obtain accurate fMRI activation maps. In this work, we discover that the signal loss in fMRI can be recovered considerably by locally shimming the field in the IFC using the magnetic field generated by currents in the coils held in the mouth.

A volume selective z-shim EPI sequence was used to acquire whole brain images with and without the intra-oral shim at 3T. The intra-oral shim greatly reduced signal loss and local image distortion at the orbito-prefrontal cortex. The volume selective z-shim technique also effectively reduced signal loss at the orbito-prefrontal cortex. A combination of the z-shim technique with the intra-oral shim provided the most effective reduction of signal loss and local image distortion caused by the susceptibility effect at the orbito-prefrontal cortex.

EPI is highly sensitive to static magnetic field inhomogeneities, which lead to image distortions in the phase-encoding direction. The degree of local image compression or stretching is a function of the static field gradient (SFG) in the direction. The degree of distortion can also be minimized by setting the phase encoding direction of the scan plane in the direction of the smallest SFG. In this study, we introduce a method for optimizing the EPI phase encoding direction within subjects using 3D fieldmap data.

In spin-echo echo-planar imaging (SE-EPI), significant signal decay can occur during the relatively long readout window due to static magnetic field inhomogeneities. Changes in the spin echo signal observed during activation may therefore be due in part to changes in T2’, not purely to changes in T2. Previous simulations have estimated that up to 38% of the spin-echo signal may be due to these effects. In this study, we measure this effect in a phantom, using an applied electric current to modulate the T2’ during the readout. Significant SE-EPI signal changes were found from changes in T2’ confirming earlier simulations.

We develop a new acquisition strategy based on asymmetric spin echo that allows single-shot high resolution T2*-weighted imaging with the use of a single long acquisition window. This strategy divides the k-space coverage into the acquisition of an FIR and two or more asymmetric spin echo readouts that maintain the T2*-weighting of the resultant image. The acquired segments are matched and concatenated to form a partial Fourier data set that can be used to reconstruct a high-resolution image. The new method is described and the results of its implementation are presented.
**Removal of Dynamic Magnetic Field Perturbation Effects during fMRI of Gum Chewing**

David A. Soltysik1, Vinai Roopchansingh1, James S. Hyde1

1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Block design fMRI studies of gum chewing were performed using a new pulse sequence that over-samples the center of k-space. A magnetic field map can then be constructed to correct distortions in every image. Such distortions can cause signal changes that produce false activation or mask real activation. Echo-planar images corrected with this method show fewer correlated voxels likely produced by dynamic magnetic field perturbations and localized activation in the motor cortex.

**Navigated 3D fMRI vs. 2D fMRI**

Yanle Hu1, Gary Glover1

1Stanford University, Stanford, California, USA

The use of navigation to increase the Signal to Fluctuation Noise Ratio (SFNR) in the 3D stack of spirals acquisition method was examined. Comparison between 2D, 3D and navigated 3D fMRI shows that navigation correction can reduce fluctuation noise, increase SFNR and increase activation in 3D fMRI. However, 3D methods gradually lose the SFNR advantage over 2D as the slice thickness increases. This may be caused by intravoxel dephasing across the slab select direction since the signal in 3D methods is more sensitive to susceptibility-induced field gradients.

**Dual-Resolution Multi-shot Partial k-Space EPI Acquisition**

Y. Mazaheri1, E. C. Wong1, T. T. Liu1

1UCSD, La Jolla, California, USA

A method is presented that acquires an additional data set prior to echo time in interleaved partial k-space EPI acquisitions. The additional data set has lower spatial resolution compared to the multi-shot image, is echo shifted, and is sampled at each RF pulse. A field map is generated with this data to reduce geometric distortions.

**High Resolution Multislice fMRI using Interleaved EPI with Cyclic Recombination**

Wietske van der Zwaag1, Richard Bowtell1, Sarah Gutteridge1, Susan Francis1

1University of Nottingham, Nottingham, UK

The aim of this study was to develop an EPI technique for acquiring fMRI at high spatial resolution whilst retaining good temporal resolution. A 1x1x1.5 mm3 voxel size was reached using a low gradient switching frequency, a small surface coil and zoom pulses to prevent wrap around effects. Interleaved image acquisition was implemented to achieve the optimal T2* weighting. To improve temporal resolution in fMRI data the use of cyclic recombination of interleaves was assessed, and shown to result in higher z-scores, and so less false positive activation than the use of conventional (sequential) interleaved combination.

**High resolution BOSS fMRI at 1.5T**

Karla L. Miller1, Christopher deCharms1, David Ress1, John M. Pauly1

1Stanford University, Stanford, California, USA

This work presents high-resolution fMRI at 1.5T using the BOSS contrast mechanism, a new fMRI technique based on refocused SSFP imaging. BOSS imaging has high SNR efficiency and does not suffer from the poor image quality typical of BOLD data, and therefore should be a useful method for high resolution imaging. Visual activations were reliably detected using voxel sizes as small as 1x1x2 mm3. Signal changes increased from 9.1% to 15.7% as the voxel volume decreased from 4.7 mm3 to 2 mm3. The CNR of these preliminary results indicate that higher resolutions should be readily obtainable with BOSS fMRI.

**Compartmental Selectivity of Diffusion Weighted BOLD fMRI at 4T**

Charles R. Michelich1, Allen W. Song1, James R. MacFall1

1Duke-UNC Brain Imaging and Analysis Center, Durham, North Carolina, USA

Diffusion weighting (DW), spin-echo, and high field strengths can be used to suppress the large vessel contamination in conventional BOLD fMRI. We investigated the influence of these techniques on four compartments (intravascular space in and extravascular space around small and large vessels) at nine diffusion weightings. For gradient and spin-echo acquisitions, all DW applied attenuated the activation to a consistent value. Evidence of residual intravascular signal was found affirming the value of DW at high field. A reduction of DW activation from 7 to 1% by the spin-echo acquisition demonstrated the significance of extravascular large vessel effects in gradient-echo imaging.

**Echo Volumar Imaging (EVI) for High Temporal Resolution fMRI**

Wietske van der Zwaag1, Susan Francis1, Richard Bowtell1

1University of Nottingham, Nottingham, UK

EVI allows rapid acquisition of T2*-weighted volumar data, but technical difficulties have limited the technique’s widespread use in fMRI. We have therefore developed a modified EVI sequence employing: (i) rewind gradients to ensure all k-space planes are sampled in the same direction; (ii) a low number of sampled echoes, to limit TE, in conjunction with zooming; (iii) a calibration scan method, to reduce spatial distortion and Nyquist ghosting. Using this sequence, 8-slice volumar data with a voxel size of 3x3x1.5mm3 has been acquired with a temporal resolution of 167 ms and sufficient SNR for functional studies of the somatosensory cortex.
Qi Peng1, Paul Weatherald1, Jon Chia2, Jihong Wang1
1University of Texas Southwestern Medical School, Dallas, Texas, USA; 2Philips Medical System Inc., Dallas, Texas, USA

The detection of electrical current in the magnetic field using MRI has recently gained more attentions for its potential applications in direct neuronal current detection. It has been shown that the weak magnetic field change could be detected using phase imaging and different MR sequences such as spin echo, SE or GE EPI was employed. We present here the feasibility of a new method to detect weak magnetic field fluctuation induced by alternating currents, with 10 ms temporal resolution using a balanced SSFP sequence.

14:16 1007. T2 and T2* Triple Spiral Acquisition for fMRI on 3T Systems
David C. Zhu1
1University of Chicago, Chicago, Illinois, USA

Brain regions at air-tissue interfaces often suffer from severe signal loss in gradient-echo based BOLD fMRI studies, especially on high-field such as 3T systems. The gradient-echo based spiral-in/out acquisition technique proposed by Glover et al. has shown an advantage in increasing signal-to-noise ratio and in reducing susceptibility artifacts. Spin-echo based techniques have also been demonstrated to be valuable for studies on regions suffering from severe signal loss on 3T systems. A triple spiral acquisition technique is proposed here to take advantage of the benefits of both the spin-echo and spiral-in/out acquisitions without sacrificing additional temporal/spatial resolution.

14:17 1008. The Relationship between Changes in CBF and CBV is Dynamically Varying Throughout Stimulus Duration but Complex Following Stimulus Offset
Ikuhiro Kida1, Fahmeed Hyder1
1Yale University, New Haven, Connecticut, USA

Quantification of the relationship between changes in CBF and CBV during functional activation is necessary to calculate changes in CMRO2 from multi-modal MRI measurements. We investigated the relationship between dynamic changes in CBF and CBV by combing the modified fMRI method for CBF with contrast agent for CBV during forepaw stimulation with different stimulus duration. There is a dynamically varying relationship between changes in CBF and CBV throughout stimulus duration and the relationship becomes complex following stimulus offset. This is the first evaluation of the dynamic CBF-CBV relationship using only MRI methods.

14:18 1009. Measurement of Transient State Cerebral Blood Volume Change with Compensation for T2 Variation
Juan-Jie Wang1, HoLing Liu1, Yi-Chin Chen1
1ChangGung University and ChanGung Memorial Hospital, Taipei, Taiwan

Cerebral Blood Volume (CBV) changes at transient state was measured by a T2 weighted inversion prepared Spin Echo EPI sequence using an Event Related fMRI (ER-fMRI) paradigm. Flow nulling gradients were applied to selectively attenuate the blood signals. CBV changes due to 1-s visual stimuli during brain activation were dynamically measured with a temporal resolution of 1s. The maximum CBV change and averaged time courses were calculated from two normal volunteers.

14:19 1010. Measurement of Dynamic CBV Changes During Brain Activation Using A Tissue Suppression Method
Chang-Wei Wu1, Jyh-Horng Chen1, Ho-Ling Liu1
1National Taiwan University, Taipei, Taiwan; 2Chang Gung University, Chang Gung Memorial Hospital, Kweishan, Taiwan

Inversion recovery pulse sequence with inversion time that suppressed tissue signals was proposed to estimate the regional cerebral blood volume change in this study. The detected contrast-to-noise ratio was 1.0 ± 0.19 at 1.5T, which was approximately two times larger than that of the previously published method with blood signal suppression. The mean CBV change during steady-state brain activation was estimated to be 31%, assuming 5% resting CBV and 8.1% cerebrospinal fluid volume fraction.

14:20 1011. Quantification of CBV Changes During Brain Activation Using IR Methods: A Model Based on Fast Water Exchange and Non-Equilibrium Flow Effect
Chang-Wei Wu1, Ho-Ling Liu1, Jyh-Horng Chen1
1National Taiwan University, Taipei, Taiwan; 2Chang Gung University, Chang Gung Memorial Hospital, Kweishan, Taiwan

Negative response has been observed by non-slice-selective inversion recovery (NSIR) sequence during neural activation and the phenomenon was speculated to be relative to variation of cerebral blood volume (CBV) fraction. However, the quantification of CBV changes using this method is still hindered by the complicated biophysical implications in the signal. In this study, we introduce a model for NSIR signal based on fast water exchange and non-equilibrium flow effect. Simulations are performed to examine these effects on the estimation of CBV changes at both steady and transient state.
<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
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<tr>
<td>14:21</td>
<td>Detection of Blood Flow Changes during Cognitive Task Activation using CASL</td>
<td>Toralf Mildner&lt;sup&gt;1&lt;/sup&gt;, Stefan Zysset&lt;sup&gt;1&lt;/sup&gt;, Robert Trampel&lt;sup&gt;1&lt;/sup&gt;, Wolfgang Driesel&lt;sup&gt;1&lt;/sup&gt;, Harald E. Möller&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1Max Planck Institute of Cognitive Neuroscience, Leipzig, Germany&lt;br&gt;Multi-slice perfusion-based fMRI (p-fMRI) is demonstrated with a color-word matching Stroop task as an established cognitive paradigm. Continuous arterial spin labeling (CASL) was achieved using a circular coil of 6-cm diameter placed over the left common carotid artery. CASL was applied for all repetitions of the functional run in a quasi-continuous fashion, i.e. it was interrupted during image acquisition only. For comparison, BOLD contrast was detected using GE-EPI. Positive activations in BOLD imaging were found in p-fMRI as negative signal changes. Negative BOLD signals (deactivation) appeared as positive signals in p-fMRI indicating areas with decreased cerebral blood flow (CBF).</td>
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<td>14:22</td>
<td>The b factor Dependence of Signal Characteristics in Dynamic ADC Functional Imaging</td>
<td>Todd B. Harshbarger&lt;sup&gt;1&lt;/sup&gt;, Allen W. Song&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1Duke University, Durham, North Carolina, USA&lt;br&gt;Dynamic changes in the apparent diffusion coefficient offer a contrast mechanism for functional brain imaging. The ADC contrast is thought to originate in the arterial networks with decaying sensitivity downstream. We investigated the signal differences in areas found to be active based on ADC contrast with multiple degrees of diffusion weighting. We produced areas using ‘high b’ factor and ‘low b’ factor conditions. A comparison of the signal characteristics of the two conditions is consistent with the low b ADC arising from larger vessels upstream, and the high b ADC changes resulting from smaller vessels such as capillaries.</td>
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<td>14:23</td>
<td>Comparison of Point Spread Functions of BOLD and ASL fMRI at an Ultra-High Magnetic Field, 9.4 T</td>
<td>Jaekeun C. Park&lt;sup&gt;1&lt;/sup&gt;, Itamar Ronen&lt;sup&gt;1&lt;/sup&gt;, Louis J. Toth&lt;sup&gt;2&lt;/sup&gt;, Kamil Ugurbil&lt;sup&gt;3&lt;/sup&gt;, Dae-Shik Kim&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1University of Minnesota Medical School, Minneapolis, Minnesota, USA; 2Boston University School of Medicine, Boston, Massachusetts, USA&lt;br&gt;Point spread function (PSF) in fMRI methods is of crucial importance in determining the limits of the spatial resolution provided by imaging techniques based on the hemodynamic response. The PSFs of BOLD and CBF fMRI were investigated in the cat visual cortex at 9.4 T. The border between the areas activated by the stimulation of the upper and the lower visual fields is observed with both techniques. Our results indicate that the spatial specificity of CBF is approximately 3 times higher than of GE BOLD (about 0.5 mm), and is thus suitable to investigate sub-millimeter cortical structures.</td>
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<td>14:24</td>
<td>High Spatial Resolution Functional Imaging of Perfusion and BOLD Contrast in Humans at 7 Tesla</td>
<td>Richard Hoge&lt;sup&gt;1&lt;/sup&gt;, Christopher Wiggins&lt;sup&gt;1&lt;/sup&gt;, Graham Wiggins&lt;sup&gt;1&lt;/sup&gt;, Christina D. Triantafyllou&lt;sup&gt;4&lt;/sup&gt;, Andreas Potthast&lt;sup&gt;5&lt;/sup&gt;, Larry Wald&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1A.A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA; 2Siemens Medical Systems, Erlangen, Germany&lt;br&gt;We have performed high spatial resolution functional imaging of perfusion and BOLD contrast in human subjects at a field strength of 7 Tesla. A locally designed volume RF coil was used for excitation and detection, and observations suggest that dielectric focusing may lead to favorable characteristics for adiabatic inversion in the neck. Activation and perfusion images demonstrated high contrast and spatial definition.</td>
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<td>14:25</td>
<td>Measuring Blood Volumes using CPMG Echo-Space Dependence at 3T</td>
<td>A G. Gardener&lt;sup&gt;1&lt;/sup&gt;, P A. Gowland&lt;sup&gt;1&lt;/sup&gt;, S T. Francis&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1University of Nottingham, Nottingham, UK&lt;br&gt;We have implemented a multi-echo, CPMG sequence in-vivo to investigate the echo-spacing dependence of R&lt;sub&gt;2&lt;/sub&gt; (transverse relaxation rate) in brain tissue. Blood R&lt;sub&gt;2&lt;/sub&gt; is dependent on echo-spacing (τ&lt;sub&gt;eq&lt;/sub&gt;) and oxygenation, with lower oxygenated venous blood displaying the greatest increase in R&lt;sub&gt;2&lt;/sub&gt; at longer echo-spacings. We have measured R&lt;sub&gt;2&lt;/sub&gt; in the occipital lobe in regions of grey matter, CSF and sagittal sinus. The venous blood R&lt;sub&gt;2&lt;/sub&gt; dependency on τ&lt;sub&gt;eq&lt;/sub&gt; was then used to assess the venous blood volume fraction in grey matter regions. Future studies will investigate changes in blood oxygenation and volume during neuronal activity.</td>
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<td>14:26</td>
<td>Dependence of CBV-Weighted fMRI Signals on Dose of Contrast Agents</td>
<td>Ping Wang&lt;sup&gt;1&lt;/sup&gt;, Fuqiang Zhao&lt;sup&gt;1&lt;/sup&gt;, Seong-Gi Kim&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1Brain Imaging Research Center, Pittsburgh, Pennsylvania, USA&lt;br&gt;Signal change in CBV-weighted fMRI signal is dependent on absolute CBV change, dose of contrast agents, and baseline signal intensity. Thus, dose-dependent CBV-weighted fMRI signals were examined in the cat visual cortex at 5, 10, and 15 mg/kg MION conditions. Dependence of baseline R&lt;sub&gt;2&lt;/sub&gt;* changes on MION dose was also determined. Baseline R&lt;sub&gt;2&lt;/sub&gt;* change induced by MION is the highest at the surface of the cortex, while functional percent-signal changes are the highest at the middle of the cortex, irrespective to the dose of MION.</td>
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Rasmus M. Birn1, Karen E. Bove-Bettis1, Peter A. Bandettini1
1National Institute of Mental Health, Bethesda, Maryland, USA

Blood oxygenation level dependent (BOLD) functional MRI has recently been used in conjunction with a breath-holding task to assess global increases in cerebral blood flow. The purpose of this study is to compare BOLD imaging during breath-holding with signal changes induced by a bolus of Gd-DTPA. Both of these measures show the largest changes in gray matter and large vessels. Since oxygenation changes from breath-holding occur primarily in the veins whereas Gd-DTPA bolus induced changes reflect blood volume in both arteries and veins, differences in these maps may reflect voxel-wise differences in the contribution from arterial and venous sources.

14:28 1019. Vessel Size Mapping in Human Brain using a Bolus Injection of Gd-DTPA and Combined GE and SE EPI
Rasmus M. Birn1, Karen E. Bove-Bettis1, Peter A. Bandettini1
1National Institute of Mental Health, Bethesda, Maryland, USA

Variations in the vascular architecture across different brain regions can often dominate underlying differences in the neuronal activation. Mapping the vessel size for different brain areas is therefore an important step both for identifying vascular pathologies and in improving our understanding of the BOLD signal. In this study we use a combined gradient-echo spin-echo technique, with and without diffusion weighting, during a bolus injection of contrast agent, Gd-DTPA, to estimate the mean vessel size in each brain voxel. This measurement is shown to correlate well with the magnitude of the BOLD signal.

14:29 1020. Bolus Gd-DTPA Washout Dynamics Predict BOLD Dynamics
Rasmus M. Birn1, Karen E. Bove-Bettis1, Peter A. Bandettini1
1National Institute of Mental Health, Bethesda, Maryland, USA

The temporal dynamics of the blood oxygenation level dependent (BOLD) fMRI response varies considerably between voxels, and between subjects. In this study, we investigate the vascular contribution to this variability by comparing the dynamics of the BOLD response to various aspects of the dynamics of Gadolinium bolus induced signal changes. Our hypothesis is that the wash-out time of the Gd bolus is more reflective of the time for blood to travel from the arterioles through veins and is therefore more predictive of BOLD onset time and duration. The studies presented here show that this correlation is indeed the strongest.

14:30 1021. Manganese-Dependent Contrast Detection of Brain Activation in Response to Emotional Stimuli
Jeffrey R. Tenney1, Wei Chen1, Timothy Q. Duong1, Jean A. King1
1University of Massachusetts Medical School, Worcester, Massachusetts, USA

Recent use of manganese-enhanced MRI (MEMRI) to assess the neural circuitry involved in autonomic and somatosensory paradigms has been promising. The current study addresses the feasibility of utilizing this technique to explore complex emotional processes. Since olfactory cues are particularly salient to animals, we utilized a fear-inducing scent to assess the neural circuitry sub-serving olfactory emotional responding. The results clearly demonstrate that with adequate controls, MEMRI can be utilized to investigate such complex neural circuitries. Neuronal activation is in concordance with human neuroimaging studies linking several sub cortical and amygdalar projections to both seen and unseen fear.

14:31 1022. Anisotropy of the BOLD Response
Egill Rostrup1, Matthew Liptrot1, Kirsten Nielsen1, Lars Hanson1
1Copenhagen University Hospital Hvidovre, Hvidovre, Copenhagen, Denmark

The BOLD response results from both intra- and extra-vascular effects, and can be altered by manipulating the relative contribution of these compartments. In the present study a novel approach is demonstrated, in which T2*-weighted imaging is combined with multidirectional diffusion weighting at moderate b-values. The spatial distribution of BOLD signal reduction, as well as its sensitivity to the spatial direction of diffusion encoding, is demonstrated. Low levels of attenuation anisotropy are generally seen in the visual cortex, although areas around large vessels show noticeable differences.

14:32 1023. Improved Quantitative Measurement of Oxygen Extraction Fraction at 3T
R E. Ansorge1, T A. Carpenter1, S G. Harding1, P Satangput1, N R. Shaw1
1University of Cambridge, Cambridge, Cambridgeshire, UK

The oxygen extraction fraction (OEF) in grey and white matter for 8 normal volunteers was measured using MRI imaging with SPGR and GESSE sequences. The theoretical model of D.A. Yablonskiy and E.M.Haacke describing signal dephasing in the presence of deoxyhemoglobin was used to estimate OEF and cerebral blood volume (CBV). Simultaneous fitting was used to estimate the model parameters. The SPGR sequence is used in a novel way to correct for signal attenuation due to magnetic field inhomogeneities in the large GESSE voxels.
14:33  **1024. Reversed Spiral SENSE for fMRI**

_Victor Andrew Stenger^1, Brad P. Sutton^1, Fernando E. Boada^1, Jeffery A. Fessler^2, Douglas C. Noll^1_

^1University of Pittsburgh, Pittsburgh, Pennsylvania, USA; ^2University of Illinois, Urbana, Illinois, USA; ^3University of Michigan, Ann Arbor, Michigan, USA

A reversed spiral SENSE acquisition is proposed for fMRI. The use of SENSE allows for a higher resolution single-shot reversed spiral acquisition without an unnecessarily long TE or for an equivalent acquisition with reduced gradient duty cycle demands. Combined with the favorable off-resonance characteristics of reversed spirals, an efficient single-shot method for acquiring high-resolution images with reduced susceptibility artifact is created. We present single-shot brain images and fMRI activation maps with resolutions of 96x96 and 112x112 at 3T using a 4-channel coil and a SENSE reduction factor of 2.

14:34  **1025. An Investigation of GRAPPA in Conjunction with fMRI of the Occipital Cortex at 3T**

_Mark William Little^1, Annie Papadaki^2, Donald William McRobbie^2_

^1Royal Free Hampstead NHS Trust, London, UK; ^2The Hammersmith Hospitals NHS Trust, London, UK

The aim of this study was to investigate the effect on BOLD response from visual stimulation at 3T when using GRAPPA in conjunction with single shot EPI. Parallel imaging has been shown to reduce blurring due to T2* decay, and image distortions due to off resonance spins associated with EPI. Visual stimulation at 3T was used on five normal subjects. Results show that GRAPPA has no detrimental effect on BOLD signal, indeed there is increased extent of activity with increased reduction factor.

14:35  **1026. Ultra Fast BOLD fMRI Using Single Shot Spin-Echo EPI With SENSE at 3 Tesla**

_Said Boujraf^1, Paul Summers^1, Tijani Lamhamdi^1, Klaus Prüssmann^2, Spyros Kollias^3_

^1University of Fez, Fez, Morocco; ^2University Hospital Zurich, Zurich, Switzerland; ^3ETHZ, Zürich, Switzerland

SENSE have been improved to use sampling efficiency in single-shot (SS) EPI. SENSE together with SS SE-EPI may further reduce off-resonance artifacts which are increased significantly when imaging field increases, and improve spatial resolution. The goal of this work was to investigate the BOLD response of SENSE adapted SS SE-EPI on 3 Tesla scanner. We performed an fMRI study using SS SE-EPI with SENSE in the context of a motor task involving brain areas that have known activation pattern. Susceptibility artifacts were reduced. This optimized sequence revealed physiologically expected activation, with precise and specific BOLD changes in the underlined microvasculature bed.

14:36  **1027. Whole Brain fMRI in Human at Ultra-High Field with Parallel SENSE Imaging**

_Pierre-Francois A. Van de Moortele^1, Gregor Adrian^1, Steen Moeller^1, John Strupp^1, Peter Andersen^1, Carl Snyder^1, Tommy Vaughan^1, Kamil Ugurbil^1_

^1University of Minnesota Medical School, Minneapolis, Minnesota, USA

In this paper, we demonstrate fMRI of the whole brain at 7Tesla with EPI and parallel imaging, taking full advantage of: a) the intrinsic higher signal to noise at higher field, b) the higher potential reduction factor obtainable at higher magnetic field, c) a coil design based on microstripe transceive arrays for parallel imaging. A reduction factor of 4 allowed to acquire 40 slices (3mm thickness) every 6 seconds with a 2x2mm2 in plane resolution with no EPI segmentation. In a finger tapping task, activation were detected in expected locations over the brain, including motor cortex, SMA, basal ganglia, cerebellum.

14:37  **1028. Optimization of 3D EPI SENSE Techniques for fMRI of Highly Inhomogeneous Areas**

_Ronald Roel Peeters^1, Stefan Sunaert^2, Marion Smits^2, Paul Van Hecke^1_

^1Katholieke Universiteit Leuven, Leuven, Belgium; ^2Erasmus MC, Rotterdam, Netherlands

The advent of parallel imaging techniques makes it possible to perform fMRI studies in brain areas which previously suffered from susceptibility artifacts in standard BOLD fMRI experiments. The trend towards higher magnetic field scanners makes the requirement even more actual. In this study it was demonstrated that the 3D EPI SENSE technique makes it possible to perform fMRI studies in these areas. The acquisition sequence was optimized to obtain useful image quality in the orbitofrontal cortex in an event related taste/smell experiment.

14:38  **1029. An Optimized EPI Pulse Sequence Using SENSE for fMRI Studies of Orbitofrontal and Medial Temporal Brain Areas**

_Haiying Tang^1, Matthais H. Tabert^2, Mark Albers^2, D P. Devanand^1, Ed X. Wu^1, Truman R. Brown^1_

^1Columbia University, New York, New York, USA; ^2Columbia University College of Physicians and Surgeons and the NewYork State Psychiatric Institute, New York, New York, USA

Regional signal losses resulting from susceptibility differences at air-tissue interfaces pose a particular problem in T2*-weighted images. Here, we access signal recovery with an optimized versus standard EPI pulse sequence. In addition, with these two sequences we evaluated BOLD sensitivity changes in response to olfactory, motor, and visual stimulation. Images were acquired at 1.5T with a SENSE head coil. Using this optimized sequence with SENSE, we were able to recover signal at the base of the brain without seriously diminishing BOLD sensitivity in other areas. Additional improvements in SNR and signal recovery may be obtainable with the SENSE at 3T.
**Optimal SENSE Factor for BOLD fMRI at 3T**

Paul S. Morgan¹, F Andrew Kozel², Mark S. George², Kevin A. Johnson², Gordon C. Baylis³, Chris Rorden¹

¹University of Nottingham, Nottingham, UK; ²Medical University of South Carolina, Charleston, South Carolina, USA; ³University of South Carolina, Columbia, South Carolina, USA

FMRI acquisitions at 3T are susceptible to spatial distortion. Using parallel imaging techniques such as SENSE can reduce both spatial distortion and acquisition time. However, the effect of the SENSE reduction factor, R, on BOLD activation has only been studied by a small number of groups. We investigated the effect of a range of R values (1 to 3.2) on BOLD activation, using both fixed TR and reduced TR and found the main effect of using SENSE was to reduce acquisition time, with optimal activation when R=2.

**Sensitivity Benefits from Ultra-Fast fMRI: Monte Carlo Analysis Based on Temporal Noise in PRESTO-SENSE Acquisitions**

Arjen van der Schaaf¹, R.S. Kahn¹, Nick Ramsey¹

¹University Medical Center Utrecht, Utrecht, Netherlands

The sensitivity of fMRI to detect cortical activation depends on the combined temporal properties of the signal noise and the acquisition technique. Ultra-fast scan methods benefit from over-sampling of high-frequency physiological noise components, but suffer from temporal correlations between samples. We measured time-series of temporal noise with ultra-fast PRESTO-SENSE fMRI methods in resting subjects at various scan speeds. We used Monte Carlo simulation to evaluate the overall effects of acquisition speed on sensitivity. We find a sensitivity scaling behavior that favors fast scanning sequences and follows a power-law function with on average 12% sensitivity gain from each factor two speedup.

**Hunting for Neuronal Currents: Absence of Rapid MRI Signal Changes During Visual Evoked Response**

Masaki Fukunaga¹, Jaccio A. de Zwart¹, Peter van Gelderen¹, Peter Kellman¹, Jeff H. Duyn¹

¹National Institutes of Health, Bethesda, Maryland, USA

The use of MRI for the detection of neuronal currents during human brain activation has been suggested. However, it has not been demonstrated convincingly that MRI has adequate sensitivity to measure neuronal currents in vivo and that neuronal current effects can be separated from other effects, e.g. BOLD. Here we used a sensitive method that allows separation of slow (BOLD) and fast (neuronal currents) responses in fMRI. Both 3.0 T fMRI and MEG studies were performed using the same visual stimulus on the same volunteers. Results show very significant MEG and BOLD fMRI responses, but no MRI-detectable neuronal response.

**Improving EPI Imaging Quality and Sound Levels with Bandwidth Selection**

Katie McMahon¹, Alan Pringle¹, Matt Eastburn¹, Donald Maillet¹

¹University of Queensland, Brisbane, Queensland, Australia

EPI is a rapid sequence that has been applied with great success to functional magnetic resonance imaging. However, the oscillating gradients in EPI can produce artefacts such as Nyquist ghosting, plus they generate a high level of acoustic noise. Maximum bandwidth is desirable in EPI to reduce echo spacing and geometric distortions, so although low bandwidths generate low noise and ghosting, a higher bandwidth which is in sync with the harmonics of the gradients provides a much better alternative. The relationship between frequency of readout and Nyquist ghosting plus acoustic noise was investigated at 1.5 and 4T systems.

**High Resolution fMRI with Asymmetric SE EPI and Its Application in the Study of Tonotopic Organization in Human Auditory Cortex**

L. Tugan Muftuler¹, Orhan Nalcioglu¹

¹University of California, Irvine, California, USA

We carried out an fMRI study in a 4T MRI scanner with single-shot Asymmetric Spin-Echo EPI Sequence with partial k-space scanning to obtain high spatial resolution and specificity. A healthy single subject was studied in this preliminary experiment. Auditory stimuli were presented with alternating blocks of 250 Hz and 2000Hz, each of which is amplitude-modulated by a 20Hz sine wave. Each block lasted 20 seconds with alternating 20s baseline of silence. Results depict distinct activation foci in the auditory cortex responding to these two different tones.

**Spinal fMRI of Multiple Sclerosis: Comparison of Signal Intensity Changes with Healthy Controls**

Amanda D. Bergman¹, Corinne LeBlanc², Patrick W. Stroman³

¹University of Manitoba, Winnipeg, Manitoba, Canada; ²Health Sciences Centre, Winnipeg, Manitoba, Canada; ³National Research Council, Winnipeg, Manitoba, Canada

The SEEP effect is theorized to arise from an increase in extravascular water content corresponding to neuronal activity and is used in spinal fMRI to detect activity in the gray matter of the spinal cord. We present the first spinal fMRI study of multiple sclerosis patients imaged at the level of a multiple sclerotic plaque or functional deficit. A significantly greater change in signal intensity was observed in MS patients as compared to healthy controls. Given the altered blood-CNS barrier in MS, these results support the theory that SEEP signal changes arise from an increase in extravascular water content.
14:45  **1036. Nicotine Induced Changes in Muscle BOLD Signal at 3T**  
Daniel Bulte, Sonya Bells, Michael D. Noseworthy  
1The Brain-Body Institute, Hamilton, Ontario, Canada

The vasomodulation effects of nicotine on skeletal muscle BOLD signal were investigated using a GE Excite 3T system. A hyperoxia paradigm showed significant activations in the soleus muscle reflecting its high density of microvasculature. Pre and post exercise states were compared with and without the presence of nicotine. Nicotine was shown to significantly increase the BOLD signal in the slow-twitch, type-I soleus muscle while having little or no effect on the fast-twitch, type II gastrocnemius. Cardiac output and vasodilation effects are the suggested cause. The results demonstrate the viability of the technique for studying vascular pathology in skeletal muscle.

14:46  **1037. Prolongation of Longitudinal Relaxation During Motor Activation**  
Uwe Klose, Klaus Groeschel, Petros Martirosian, Axel Riecker, Andreas Kastrup  
1University of Tuebingen, Tuebingen, Germany

The signal enhancement in EPI measurements with slice-selective and nonselective inversion during motor activation was examined in this study. Signal intensity was evaluated in rest and during activation for several inversion times and T1 relaxation times were calculated. During activation, a prolongation of the longitudinal relaxation was found, which was more pronounced in measurements with nonselective inversion. For long inversion times, this effect leads to a reduction of signal during activation and thereby compensates the BOLD-effect.

14:47  **1038. A Low-Cost MRI Compatible Computer Mouse**  
M. Richter, K. J. Behnke, P. Hutter, C. Yee-Chan, A. Dettwiler, W. Richter  
1Princeton University, Princeton, New Jersey, USA

For many fMRI applications, a computer mouse would be a useful device to monitor and record subject behavior. We have constructed an MRI compatible computer mouse by shielding a commercial nonmagnetic mouse and filtering its output. We tested the device in phantom experiments as well as in a human fMRI experiment and found no interference or degradation of the signals or maps. This mouse can easily be constructed in any laboratory at a material cost of less than $250.

fMRI Quality Control, Devices, and EEG

Room F  Tuesday 13:30 - 15:30

13:30  **1039. Development of a Reference Phantom for fMRI Studies**  
Peter Koopmans, Cris Lanting, Maarten Versluis, Hans Hoogduin  
1University of Groningen, Groningen, Netherlands

A phantom is developed that can provide a reference signal for fMRI studies. It can be placed next to a subjects head. First results for a motor task are presented. The phantom will be used to study intersession variability in fMRI.

Ian Marshall, Alan Moodie  
1University of Edinburgh, Edinburgh, UK

Scanner stability is crucial in running functional imaging studies, for which activation signals are of the same level as random variation and drift. We present the findings of an fMRI Quality Assurance (QA) programme spanning three years of use of a GE 1.5T scanner. During fMRI runs of 100 volumes, mean signal and noise levels dropped by 0.1-0.3% of their initial values. Ghosting increased markedly during scans, such that signal:ghost ratio (SGR) dropped by 4-8%. Long term month-to-month variation in mean signal and SNR were 0.7% and 2% respectively, whilst SGR displayed more variation (16%).

13:32  **1041. A fMRI Study of the SMARTPHANTOM**  
Hu Cheng, Qun Zhao, Diana Spencer, George Randy Duensing, William A. Edelstein  
1MRI Devices Corporation, Gainesville, Florida, USA; 2MRScience LLC, Schenectady, New York, USA

An electronic phantom is designed to simulate the BOLD signal by direct data acquisition from the MRI scanner. The signal enhancement level and SNR are both adjustable to model the brain activation in different situations. The simulation data are processed with BrainVoyager to obtain t maps of GLM analysis. The results are compared with numerical simulation using the same settings. Based on real MRI acquisition, this phantom will provide a ground truth for statistical analysis as well as give insight on the performance of a MRI system in the study of fMRI.
13:33 1042. An fMRI-Compatible Writing Device For Investigating the Neural Substrates of Drawing, Copying and Tracing

Richard Mraz, Susanne Ferber, Nicole Baker, Simon J. Graham
1Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario, Canada; 2University of Toronto, Toronto, Ontario, Canada

The purpose of this study was to design, develop and validate a device for conducting drawing tasks during fMRI. Nicknamed the virtual stylus, this device provides the unique opportunity to study the neural basis of a skill that only humans can perform: drawing a concrete object. After a brief training session, subjects were able to operate the virtual stylus comfortably with limited head motion. A preliminary fMRI experiment examined 6 subjects as they performed drawing, copying, and tracing. Interesting differences in brain activity were evident in frontal and parietal regions, indicating the utility of the virtual stylus for such studies.

13:34 1043. An fMRI Study of Touching a Virtual Object Using a Data Glove with Tactile Feedback

Jeonghun Ku, Richard Mraz, Nicole Baker, Konstantine K. Zakzanis, Jang Han Lee, In Y. Kim, Sun I. Kim, Simon J. Graham
1Hanyang University, Seoul, Republic of Korea; 2Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario, Canada; 3University of Toronto, Toronto, Ontario, Canada

We designed and validated an fMRI-compatible data glove with built-in vibrotactile feedback for use during virtual reality experiments. To illustrate the glove’s utility, simple fMRI experiments were performed involving repetitive touching of a virtual object with and without tactile feedback. Subject performance was assessed using questionnaires, finger position measurements, and images of brain activity. Questionnaire scores indicated that subjects felt an increased sense of “presence” within the virtual environment during trials with tactile feedback. Brain activity in somatosensory, motor, parietal and frontal cortices showed interesting differences for the two tasks, resulting from processing sensory input with different levels of realism.


Kyung Hwan Kim, Hyo Woon Yoon, Myung Sung Song, Hyun Wook Park
1KAIST, Daejeon, Daejeon, Republic of Korea; 2Electrical Engineering, Daejeon, Republic of Korea

Ballistocardiac pulse artifact is one of the most significant factors that hinders simultaneous recording of electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI). The purpose of this study was to develop a novel heartbeat artifact removal algorithm that resolves problems of several previous methods. Our method consists of mean waveform subtraction, selective removal of wavelet coefficients, and adaptive filtering. The recursive least square adaptive filtering operates without dedicated sensor for the reference signal, and it is turned on only when the mean subtraction and wavelet-based noise removal is not satisfactory.

13:36 1045. Simultaneous Multimodal Acquisition of Surface-EMG, EEG and fMRI

Matthias Moosmann, Petra Ritter, Jens Steinbrink, Arno Villringer
1Charité, Humboldt University Berlin, Berlin, Germany

We employ the combination of three modalities – surface-electromyocardiogram of chin and extremities, EEG and fMRI – with continuous data acquisition for the first time. This is critical for many scientific as well as for clinical issues. It is the prerequisite for vigilance monitoring during fMRI measurements and provides important additional information for studies involving the motor system. Applying a blocked hand movement paradigm during fMRI scanning we show that MR artifacts can be corrected sufficiently.

13:37 1046. Epileptic Focus Localization using EEG-fMRI Fusion

Michiroy Negishi, Todd Constable
1Yale University, New Haven, Connecticut, USA

In this study, we present a new way to combine simultaneously acquired EEG and fMRI signals for epileptic focus localization. Both signals are decomposed into their respective spatial and temporal patterns using the Singular Value Decomposition, and are recombined to obtain an estimate of the underlying brain activities in the form of a lattice of current dipoles with a temporal resolution of EEG and a spatial resolution of fMRI. An initial application of this method revealed two distinct underlying activities, one corresponding to an early posterior inferior temporal activity, and another corresponding to a later superior medial frontal activity.


1Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; 2KAIST, Daejeon, Republic of Korea; 3Boston University, Boston, Massachusetts, USA

We developed and implemented an fMRI method, capable of delivering high-resolution definition of task-specific brain activities as real-time biofeedback signal (i.e. neurofeedback). We applied the method to guide healthy subjects to voluntarily modulate the cortical functions in the primary and secondary auditory areas by adjusting the level of attention to the external auditory stimuli. We demonstrated that fMRI neurofeedback successfully assisted the subjects to achieve a significant increase in the size of activation compared to demographically-matched subjects undergoing the same task without the neurofeedback. Our results suggest that fMRI neurofeedback has the potential in the enhancement/modulation of cognitive attention.
13:39  1048. **Functional Anatomy of Human Sleep Spindles using Simultaneous EEG-fMRI Recording**

*Takeyuki Mori*, Kimitaka Anami, Fumiko Tanaka, Takashi Ohnishii, Hiroshi Matsuda

1National Center Hospital for Mental, Nervous, and Muscular Disorders, NCNP, Kodaira, Tokyo, Japan

No commonly accepted theory on whether or not specific brain regions are related to sleep spindles has been established. We attempted to detect brain regions that were correlated to sleep spindles using simultaneous EEG-fMRI. EEG and fMRI were simultaneously recorded on 3 subjects with stepping stone sampling. Post-processing was conducted on SPM99 using the power values of EEG in the range of 12-14 Hz. In result, the spindle-related BOLD sensitive regions showed almost symmetrical distributions, including primary somatosensory-motor, primary auditory, and anterior cingulate areas. These regions had widespread distribution over the brain, but dominated the specific cortical areas.

**fMRI: Other**

Room F  Tuesday 13:30 - 15:30

13:30  1049. **Brain Mapping using fMRI during Truth Telling & Deception**

*Feroze B. Mohamed*, Steven M. Platek, Nathan J. Gordon, Michael Williams, Harris Ahmad, Scott H. Faro

1Drexel University, Philadelphia, Pennsylvania, USA; 2Academy of Scientific Investigative Training, Philadelphia, Pennsylvania, USA

The purpose of this study was to investigate the regions of brain activation during truth-telling or deception by functional MRI using blood oxygenation level dependent (BOLD) contrast using a novel question technique and compare the results with those of a standard polygraph examination.

13:30  1050. **Functional MRI Study of Correlation Between Cortical Activation Involved in Mental Calculation and Different Levels of Task Difficulty**

*K PC Wong*, J HM Chan, E YK Tsui, M K. Yuen

1Tuen Mun Hospital, N.T., Hong Kong; 2Hong Kong Polytechnic University, Hung Hum, Hong Kong

Mental calculation is a complex cognitive operation. An fMRI study was conducted to evaluate the cortical activation in healthy volunteers during the performance of internal mental calculation with different levels of task difficulty. Tasks were designed to include three levels of difficulty, 1-digit-addition, 2-digit-addition and 3-digit-addition. All the tasks induced activation mainly in the prefrontal cortex and posterior parietal cortex in the supramarginal gyrus and precuneus. Greater activation is observed with increasing task difficulty, particular in posterior parietal cortex. Our results indicate that the precuneus and supramarginal gyrus are critically involved in complex mental calculation.

13:30  1051. **A 3T Event-Related fMRI Study of Natural Taste Perception**

*Marion Smits*, Ronald R. Peeters, Paul Van Hecke, Stefan Sunaert

1Erasmus MC Rotterdam, Rotterdam, Netherlands; 2U.Z. Gasthuisberg, Leuven, Belgium

Event-related fMRI of taste perception of natural stimuli such as lemon and chocolate was performed at 3T in 7 healthy volunteers. Taste stimuli consisted of “lemon” and “chocolate.” fMRI signals in orbitofrontal cortex were detected using a 3D SENSE EPI fMRI sequence using a SENSE reduction factor of 6, resulting in a significant reduction of susceptibility artefacts in that area. Significant taste related activation was obtained in the orbitofrontal and insular cortices in agreement with other studies using “non-natural” taste stimuli.

13:30  1052. **Functional Magnetic Resonance Imaging Revealed Cortical and Subcortical Neural Activations During Expectancy and Anticipation Processing in a Time Estimation Task**

*Tetsuji Tsukamoto*, Yasunori Kotani, Yoshimi Ohgami, Kazufumi Omura, Kohki Yoshikawa, Yasutsugu Aihara

1GE Yokogawa Medical Systems, Ltd., Hino-shi, Tokyo, Japan; 2Tokyo Institute of Technology, Tokyo, Japan; 3The University of Tokyo, Tokyo, Japan; 4Komazawa University, Tokyo, Japan; 5Tokyo Metropolitan University, Tokyo, Japan

We investigated neural activity underlying expectancy and anticipation incorporating a time estimation task with feedback stimuli to fMRI. In previous EEG studies showed stimulus-preceding negativity (SPN) was observed prior to the true feedback, while it was not observed if false feedback was used. Direct comparison of true vs. false condition revealed activations in the thalamus, putamen and caudate increased as well as pre-motor and post central areas. These results suggest the subcortical regions were involved in expectancy and anticipation processing.
We evaluate and compare the brain functions of conductive and sensorineural hearing loss patients on auditory stimulation using fMRI. Conductive hearing loss cases showed the diffuse and weak activations on the primary and secondary auditory cortex. For profound SNHL patients, the typical cortical activation patterns were that primary auditory cortex did not respond to sound stimulation. Instead, our preliminary results indicated the broad activation of secondary auditory cortex.

fMRI: Spatial and Temporal Signal Characteristics

Room G  Wednesday 13:30 - 15:30

13:30  **1053. The Comparative Cortical Activation Study on Conductive and Sensorineural Hearing Loss**

*Yongmin Chang*, Sang-Heun Lee, Jae-Joon Lee, In-Sung Kim, Young-Joo Lee, Sung-Gu Woo, Chul-Ho Sohn

1Kyungpook National University, Daegu, Korea, Republic of Korea; 2Keimyung University, Daegu, Korea, Republic of Korea

We evaluate and compare the brain functions of conductive and sensorineural hearing loss patients on auditory stimulation using fMRI. Conductive hearing loss cases showed the diffuse and weak activations on the primary and secondary auditory cortex. For profound SNHL patients, the typical cortical activation patterns were that primary auditory cortex did not respond to sound stimulation. Instead, our preliminary results indicated the broad activation of secondary auditory cortex.

13:30  **1054. Robust Detection of Ocular Dominance Columns in Humans using High Field HSE BOLD fMRI**

*Essa Yacoub*, Kamil Ugurbil, Amir Shmuel

1University of Minnesota, Minneapolis, Minnesota, USA; 2Max-Planck Institute for Biological Cybernetics, Tuebingen, Germany

The ability to reliably and reproducibly map high resolution functional architecture using fMRI techniques has been a point of debate in animal as well as human studies. Several animal and human studies have successfully mapped high resolution functional organizations, however, the robustness of the phenomenon (i.e. reproducibility and demonstration in multiple subjects), which would certainly improve the credibility of the data, has been a subject of debate. Here we demonstrate the spatial specificity of Hahn spin echo BOLD by robust mapping of ocular dominance columns in humans at the high magnetic field of 7 T.

13:31  **1055. BOLD Signal Change and its Spatial Heterogeneity in Relation to the Reversal Frequency of Checkerboard Stimuli in Human Primary Visual Cortex: A High-Resolution fMRI Study**

*Pei Sun*, Kenichi Ueno, R. Allen Waggoner, Keiji Tanaka, Kang Cheng

1RIKEN Brain Science Institute, Wako-shi, Saitama, Japan

Unlike the generally agreed dependency of the rCBF and BOLD signal change on the stimulus rate that are observed in a number of PET and fMRI studies using flashing LED or checker patterns, we found in this high-resolution fMRI study that the BOLD signal change depends little, if any, on the reversal frequency of checkerboards in Human V1. Using a differential mapping method, we further revealed, for the first time, that checkerboards of low and high reversal frequency, respectively, activated spatially segregated patches in V1 that measure ~1.5 mm in the narrow dimension.

13:32  **1056. Spatio-Temporal Characteristics of the BOLD Signal: Spin-Echo and Gradient-Echo fMRI at 3 T**

*Justin Hulvershorn*, Luke Bloy, Eugene E. Gualtieri, John S. Leigh, Mark A. Elliott

1University of Pennsylvania, Philadelphia, Pennsylvania, USA

With neuronal activity, blood flow and saturation changes occur first in capillaries and small vessels near the activation site, and gradually extend to larger draining veins. Using gradient-echo (GE-EPI) and spin-echo (SE-EPI) EPI with multiple echo times, we measured the time-to-peak (TTP) BOLD signal change in response to visual stimulus. We observed that TTP was significantly shorter in SE-EPI compared to GE-EPI, and decreased with TE. Spatial TTP maps of activated voxels revealed improved localization of V1, and discrimination from the sagittal sinus.


*Matthew J. Brookes*, Andrew M. Gibson, Peter G. Morris

1University of Nottingham, Nottingham, UK

The temporal resolution of fMRI is limited by the latency and longevity of the haemodynamic response function (HRF), these being governed by the local vasculature within the region of interest. Despite these limitations, by considering a single voxel, differences in onset times of the HRF between two tasks can be measured. In this study, we use linear regression to measure differences in onset times of the haemodynamic response for simple paced and self-paced tasks. We show that using this method, such timings can be measured, with associated errors, and thus the statistical significance of the timing difference can be inferred.
13:34 1058. Temporal Variations of the Hemodynamic Response Onset Estimated by Perfusion-Based Event-Related fMRI

Ju-chuan Huang, Yau-yau Wai, Yung-liang Wan, Ho-ling Liu

1Chang Gung Memorial Hospital and Chang Gung University, Kweishan, Taoyuan, Taiwan

This study aims to conduct perfusion-based ER-fMRI technique to assess the temporal resolution of ER-fMRI at different levels of contrast-to-noise ratio (CNR) and further to compare with BOLD-based ER-fMRI technique. Brief visual stimulation experiments were applied both on BOLD and perfusion experiments. Based on the application of the repeated-single-trial averaging technique, remarkably smaller variability (standard deviation) of the onset times was observed on the perfusion data than the BOLD data at equal CNR level. From the results, we suggest that perfusion-based techniques may lead to higher temporal resolution of fMRI.

13:35 1059. The CBF Response is a Time Invariant Linear Transform of the Underlying Neural Activity: fMRI and Electrophysiological Study of the Rat Brain

Ikuhiro Kida, Arrien J. Smith, Fahmeed Hyder

1Yale University, New Haven, Connecticut, USA

CBF-neuronal activity coupling is important in neuroimaging because CBF is used as an indicator for neural activity. We investigated the assumption that the coupling is linear and time invariant by combining the modified fMRI method for high temporal CBF measurement with local measurements of evoked field potential in a rat forepaw stimulation model. Since the coupling was found to be linear and time invariant with neuronal activity, the CBF response may be used to derive the neural activity time course when stimulus duration is longer than 4 seconds in the rat forepaw stimulation model.

13:36 1060. Temporal and Spatial Characteristics of BOLD fMRI Responses to Prolonged Tactile Stimuli in Somatosensory Cortex

Cathy Nangini, Nicole Baker, Simon Graham

1University of Toronto, Toronto, Ontario, Canada; 2Sunnybrook & Women's College Health Sciences Centre, Toronto, Ontario, Canada

Two types of prolonged tactile stimuli were delivered to investigate temporal and spatial modulation of BOLD fMRI signals in primary somatosensory cortex (SI), particularly to determine whether modulations on short and long time scales were present. Both stimuli evoked sustained SI activation that also contained onset and offset signal increases, perhaps reflecting physiological properties of stimulus-specific neurons. Additional analysis revealed transient BOLD signals in heterogeneous yet spatially distinct cortical regions which were missed using conventional, linear boxcar correlation. These results have important implications for understanding the stimulus-BOLD signal relationship.

13:37 1061. Detection of Neuronal Activity Induced Response from Task-Induced fMRI Response using Breath Hold

John Manocchio, Bharat B. Biswal

1UMDNJ, Newark, New Jersey, USA

Task-induced fMRI signal changes can be considered as neuronal activation convolved with intrinsic hemodynamic changes. As a result, it is not possible to account for any intrinsic hemodynamic changes that affect signal detection. To overcome this problem, a voxel-by-voxel estimate of the intrinsic hemodynamic transfer function (iHRF) was obtained during breath-holding, which is predominantly a hemodynamic response with negligible neuronal activity and metabolic consumption. The iHRF obtained during breath-hold was convolved with the idealized reference for the finger-tapping task to generate reference waveforms on a voxel-by-voxel basis. These reference waveforms were then correlated with their corresponding fMRI signal responses.

13:38 1062. Anesthesia: Regional Effects on Baseline and Activation Levels in Human Cortex

R. Todd Constable, R. Ramani, J. Strumbos, M. Qiu, F. Hyder, R. Shulman

1Yale University, New Haven, Connecticut, USA

This study examines the impact of an anesthetic agent on baseline brain activity levels and on region activations in motor, visual and auditory cortex stimulation tasks. Results demonstrate that anesthetic agents impact different cortical regions in specific manners, and that the incremental BOLD signal intensity is also altered by anesthetic in a task dependent manner. Such studies provide insight into baseline effects on incremental BOLD signal, and identify cortical regions maximally affected by anesthetic agents. Such regions can then be targeted by specific activation paradigms and provide a means for evaluating cortical networks involved in tasks.

13:39 1063. Fast Functional Signal Observed by Diffusion-Weighted fMRI

Allen W. Song, Tianlu Li

1Duke University, Durham, North Carolina, USA

BOLD contrast fMRI has become the dominant method to study brain function. However, hemodynamic modulations on its signal often lead to spatial dispersions and temporal delays. It is thus of high interest to investigate alternative contrast mechanism that may offer improved spatiotemporal characteristics. We have found that by using heavy diffusion weighting to remove the vascular signal and enhance the effect of incoherent spatial displacement induced by neuronal current, fast negative signal changes synchronized to the task can be detected. This finding may help take an initial step toward direct MRI detection of the neuronal activity.
Poster Sessions

13:40 1064. Is There a Change in Spin Density Associated with fMRI?
Thies H. Jochimsen¹, Harald E. Möller¹, David G. Norris²
¹Max-Planck-Institute of Cognitive Neuroscience, Leipzig, Germany; ²FC Donders Centre for Cognitive Neuroimaging, Nijmegen, Netherlands

A careful study of the fMRI signal changes at very short echo-times in spin-echo (SE) EPI at 3 T cannot confirm previous experiments which proposed a significant increase in extravascular spin density at TE = 0.

13:41 1065. A Two Compartment Model for Spin Echo BOLD Contrast: Validation at 3 T
Justin Hulvershorn¹, Luke Bloy¹, Eugene E. Gaunttiers¹, John S. Leigh¹, Mark A. Elliott¹
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

The Luz-Meiboom model predicts the T2 relaxation time for two-site exchange when the Larmor frequency varies between the two sites. This model has recently been extended to include diffusion through field gradients caused by weakly magnetic particles, such as deoxyhemoglobin. In this work, we model both the intravascular (IV) and extravascular (EV) BOLD compartments using this equation, and compare the results with those obtained from a visual fMRI experiment using multiple echo times in a spin-echo imaging series.

13:42 1066. Point Spread Function for Gradient Echo and Spin Echo BOLD fMRI at 7 Tesla
Cheryl A. Olman¹, Pierre-Francois Van de Moortele¹, Kamil Ugurbil¹
¹University of Minnesota, Minneapolis, Minnesota, USA

A perennial concern about the interpretation of BOLD fMRI data is the spatial specificity of the signal, which is expected to be impacted by the magnetic field magnitude. We have measured the point-spread function (PSF) at 7T using an established technique, which has previously estimated the gradient echo (GE) BOLD PSF to be 3.5 mm at 1.5 T. For GE BOLD at 7T, we find two components, one with a PSF similar to that at 1.5 T, and one with a PSF of 2 mm. Preliminary data for spin echo BOLD at 7T estimate the PSF at slightly less than 2 mm.

Gaohong Wu¹, Shi-Jiang Li¹
¹Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Contrast-to-noise ratio (CNR) is a very important measurement of an fMRI time course to map activation areas evoked by a specific task. Previous studies proposed different BOLD CNR models, which obtained controversial conclusions regarding CNR dependence of echo time (TE). In this study, a general BOLD CNR model was proposed, in which noise in BOLD signal was divided into three components: thermal white noise, fluctuations of apparent spin density, and fluctuations of transverse relaxation rate. TE dependence of CNR was simulated and evaluated. The proposed model was much closer in agreement with experimental data than that of the previous models.

13:44 1068. An Efficient Stimulus Design for Detecting Neuronal Non-Linearities with BOLD fMRI
Peter van Gelderen¹, Masaki Fukunaga¹, Jacco A. de Zwart¹, Peter Kellman¹, Jeff H. Duyn¹
¹National Institutes of Health, Bethesda, Maryland, USA

In this work, we modified the pseudo-random m-sequence to detect neuronal non-linearities in an fMRI study of human visual system. The new stimulus improved sensitivity by concentrating power in the BOLD frequency band while efficiently exciting the neuronal system. Checkerboard stimulation showed a significant non-linear effect in 5 subjects studied at 3.0 T.

13:45 1069. Observation and Correction of a Vascular Time-Lag Effect, Disruptive to Functional Connectivity Analysis
Omer Grigg¹, Gadi Goelman¹
¹Hadassah Hospital Medical Center, Jerusalem, Israel

To investigate the sensitivity of the functional connectivity approach, we applied connectivity histogram analysis on the layers of the rat’s cortex. We discovered a time lag effect, which disrupts connectivity measures. We hypothesize that this effect is hemodynamic in nature, caused by propagating hemodynamic changes. Using several analysis tools, we aimed to understand the physiological basis of this effect and to correct it. We describe our analysis methods, findings, the theorized physiological basis of them, and significance to functional connectivity analyses.

Markus Klarhöfer¹, Bixente Dilharreguy¹, Christ T.W. Moonen¹
¹CNRS / Université Victor Segalen Bordeaux 2, Bordeaux, France

A 3D Partial-Fourier PRESTO-SENSE sequence was used in an event-related functional motor experiment in six volunteers. Whole brain coverage and high temporal resolution was important to allow a characterization of temporal differences of the hemodynamic responses in different brain regions activated by the paradigm. Results were compared with those obtained with a multi-slice EPI sequence having the same temporal resolution but limited spatial coverage. The average temporal differences measured between supplementary motor area (SMA) and primary motor cortex (M1), and between sensori-motor cortex (S1) and M1 were similar for both methods.
Physiological Noise in fMRI: Comparison at 1.5T, 3T and 7T and Dependence on Image Resolution

Chritsina Triantafylloa,b, Lawrence L. Waldc, Christopher J. Wigginsb, Andreas Potthastc, Graham C. Wigginsb, Gunnar Kruegerb, Richard D. Hoge1
1A.A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA; 2Siemens Medical Solutions, Erlangen, Germany

Functional MRI data is susceptible to a number of different noise sources, both instrumental and subject dependent. Physiological time-course fluctuations increase in proportion to the image intensity thus potentially obviating the benefits of performing the study at higher field strength. We examine the effects of the magnetic field strength and image resolution on the physiological noise and corresponding SNR of an fMRI time-course. The results suggest that increases in image SNR, achievable at higher fields, are accompanied by increased physiological noise in fMRI time series, however at higher spatial resolutions a larger benefit from the increased field strength is observed.

Functional Connectivity in the Motor and Auditory Systems: A Reproducibility Study at 3 T

Jochen G. Hirsch1, Mark J. Lovew, Stefanie Schwenk3, Christina Rossmanithb, Michael G. Henneric3, Achim Gass1
1University Hospitals Basel, Basel, Switzerland; 2The Cleveland Clinic, Cleveland, Ohio, USA; 3University Hospital Mannheim, Mannheim, Germany

In functionally related regions of the brain, synchronised fluctuations of cerebral blood flow have been observed with BOLD MRI as well as with other techniques. In fMRI experiments reproducibility within and between subjects is limited due to numerous variables involved in the underlying physiology. We attempted to investigate the reproducibility of typical resting state fcMRI studies comparing auditory and motor fcMRI maps obtained in two normal controls at five time points in resting state or continuous activation conditions. FMRI stimulation experiments showed very stable activation results. LFBF in resting states and under continuous activation demonstrated closely matching anatomical representations.

Background 0.1 Hz Fluctuations are Not In Phase with Post-Stimulus Oscillations in BOLD fMRI

Yashar Behzadi1, Khaled Restom1, Thomas T. Liu1
1UCSD, La Jolla, California, USA

Slow oscillations with frequencies around 0.1 Hz are commonly observed in BOLD fMRI experiments, and are thought to be due to vasomotion. Low frequency 0.1 Hz oscillations in the post-stimulus BOLD response have also been observed. Using visual stimulus experiments, we show that the post-stimulus oscillations and the background vasomotion are not phase-locked. In addition, the onset of stimulus does not appear to reset the phase of the background vasomotion.

Scanner Differences In the Smoothness of fMRI Images: Implications for Multi-Center Studies

Lee Friedman1, Vincent A. Magnotta2, Stefan Posse1, FIRST BIRN3
1The MIND Institute, Albuquerque, New Mexico, USA; 2The University of Iowa, Iowa City, Iowa, USA; 3National Center for Research Resources, Bethesda, Maryland, USA

There are important “scanner/site” differences in smoothness of raw fMRI images. The ten FBIRN sites have a variety of MRI scanners and field strengths. Six use a standard EPI sequence, three use a spiral sequence, and one uses a double echo EPI sequence. Differences in smoothness affect the SNR of the fMRI data and CNR of the activation maps and will have to be taken into account in order maximize cross-site comparability of results. Such differences may be related to imaging method (EPI vs. spiral), gradient performance, image reconstruction method, reconstruction filter settings, and field strength.

To Smooth or Not to Smooth – ROC Analysis of Perfusion fMRI Data

Jiongjiong Wang1, Ze Wang1, Geoffrey K. Aguirre1, John A. Detre1
1University of Pennsylvania, Philadelphia, Pennsylvania, USA

The receiver operator characteristic (ROC) method was used to assess the efficacy of various steps in statistical analyses of perfusion fMRI image series, with emphases on the effects of temporal, spatial smoothing and task design frequency. In contrast to BOLD fMRI, temporal smoothing or filtering reduces the power of perfusion fMRI data analyses whereas spatial smoothing is beneficial to the efficacy of analyses. The power of the perfusion contrast remains constant over a wide range of task frequencies, and becomes superior to the BOLD contrast when the interval between resting and activation states is longer than 4 minutes.

Correlating EEG Alpha-Oscillations to Brain Perfusion – A Simultaneous EEG and Arterial Spin Labelling Study

Torben E. Lund1, Karam Sidaros1
1Copenhagen University Hospital, Hvidovre, Denmark

Recently a number of studies has been published where EEG alpha-power is correlated to variations in BOLD images. A common finding from these studies was negative correlation between EEG power in the alpha-band and the BOLD signal in occipital and parital areas. A positive correlation between the power in the alpha-band and the BOLD signal in the thalamus was also found. In the present study we show that EEG/ASL is possible and that previously observed negative correlations between EEG alpha-power and BOLD signal are likely to reflect true perfusion decreases, and similarly that thalamic perfusion increases with EEG alpha-power.
Poster Sessions

13:53 **1077. fMRI BOLD Response Correlates with Interhemispheric EEG Synchronization**
Reto Antoine Meuli¹, Maria Knyazeva⁎, Eleonora Fernari¹, Giorgio Innocenti², Philippe Maeder¹
¹CHUV, Lausanne, Switzerland; ²Karolinska Institute, Stockholm, Sweden

This study searches for fMRI correlates of the callosally mediated synchronization of EEG activity measured with interhemispheric coherence and show that BOLD responses are both co-localized and proportional to EEG synchronization between distant cortical sites.

13:54 **1078. Functional MRI Measured Auditory Response Properties to Tone Stimuli Differing in Intensities Near and Above Hearing Threshold: Comparison with Magnetoencephalography**
Paul Ferrari¹, Timothy PL Roberts¹
¹University of Toronto, Toronto, Ontario, Canada

The coupling of the hemodynamic BOLD response to underlying neural substrates responsible for sensory and cognitive processes is not entirely understood. In this study we use MEG to confirm the attenuation effect tones intensity on the hemodynamic response, with the aim to elucidate the response properties (sensitivity) of fMRI to changes in stimulus intensity at and above hearing sensation level (SL). MEG was able to resolve neural activation differences to changes in low stimulus intensities whereas fMRI was less clear. Results suggest that the BOLD fMRI response properties in this stimulus intensity range may not reflect the stimulus properties.

13:55 **1079. Point-Image fMRI Experiments in Awake, Behaving Macaques**
Francisca Leite¹, Wim Vanduffel², Roger Tootell², Joseph Mandeville²
¹MIT, Cambridge, Massachusetts, USA; ²MGH - NMR Center, Charlestown, Massachusetts, USA

Point-like image experiments were performed in awake, behaving macaque monkeys using BOLD fMRI at two different field strengths (3T and 7T). The resulting BOLD maps showed a discrete, point-like activation pattern, very similar to the stimulus and consistent with the expected map of neuronal activation. The results demonstrate that fMRI in trained macaques can reliably investigate retinotopy, that high-field BOLD fMRI can detect point stimuli as small as 50 arc-radians during a single scanning session, and that the fMRI spatial point spread function in macaque primary visual cortex is no larger than 2.2 mm.

13:56 **1080. Evidence of Altered BOLD Hemodynamic Response in Patients with Ischemic Stroke**
K Gopinath¹, A Moore¹, K Peck¹, B Crosson¹, R Briggs¹
¹University of Florida, Gainesville, Florida, USA

BOLD fMRI is becoming a method of choice to image the recovery of brain function after stroke. Thus far, most stroke fMRI studies have extended the principles of design and analysis of normal control subject fMRI paradigms to patient populations. In this study, we examined the hemodynamic response (HDR) of voxels in the primary auditory cortex of the infarcted and intact hemispheres of ischemic stroke patients after presentation of an auditory stimulus. Preliminary results indicate significant differences in the HDRs of the primary auditory cortex perilesional to the infarcted region compared to the intact hemisphere and to normal controls.

13:57 **1081. Simulations of the BOLD Effect using a Realistic Model of the Vasculature**
Jose Pedro R. F. Marques¹, Richard W. Bowtell¹
¹University of Nottingham, Nottingham, Nottinghamshire, UK

Current models of the BOLD effect are based on the assumption that magnetic field perturbations can be calculated by representing the vasculature as a set of randomly-oriented infinite cylinders. Here we assess the effect of using a more realistic model of the vasculature based on scanning electron microscope measurements. The field perturbation due to this model was calculated using a novel Fourier-based method and the resulting field maps used to evaluate the NMR signal evolution. Results indicate a broadly similar dependence of signal changes to those produced by the infinite cylinder model, with some interesting specific differences.

**fMRI Data Analysis**

Room G         Thursday 13:30 - 15:30

13:30 **1082. Nonlinear Analysis of Hemodynamic Response in the Fusiform Face Area**
Sung Ki Lee¹, Hyo Woon Yoon¹, Kyung Hwan Kim¹, Myung Sung Song¹, Jun-Young Chung¹, Hyn Wook Park¹
¹KAIST, Daejeon, Republic of Korea

Number of studies postulated that the linear system analysis could characterize the hemodynamic responses of fMRI data. From that reason, most of available software use this for analysis of the fMRI responses. We hypothesized that all the neural activity of the human cerebral region measured by fMRI is not underlying linear system-based hemodynamic responses. In this work, we investigated the nonlinear characteristic hemodynamic response of the fusiform face area using nonlinear system identification based on Laguerre expansion techniques. The results of nonlinear analysis showed more and broader activation region compared to the linear system analysis.
Oxygen extraction fraction can be mapped by calculating susceptibility differences ($\Delta \chi$) between venous vessels and tissue from volume fraction $\lambda$ and relaxation-rate ($R_2^*\lambda$) measurements, when a model of tissue structure is assumed. In this work a combined gradient-echo/spin-echo technique is used to sample signal-time course in a custom-built phantom with susceptibility inclusions. Two different data evaluation strategies to obtain $R_2^\lambda$, $\lambda$ and $\Delta \chi$-maps from these data are investigated. The measurements show that a procedure which fits the sampled gradient-echo before and after the spin-echo simultaneously, is superior to an independent fit to both branches.

In fMRI time-series, the amount of field distortion due to local susceptibility gradients may change with head motion, leading to movement related variance that cannot be corrected using rigid body realignment. We present a method that combines geometric distortion correction using a measured field-map with model-based estimates of how distortion changes with head motion. We show that this method has particular impact on fMRI time-series in which there is task-correlated head motion. The method reduces residual variance without removing true activations and yields an unwarped time-series that better matches the true anatomy.

Exploratory data analysis of functional MRI datasets allows researchers to identify activation areas without having to specify all the experimental parameters, expected haemodynamic response and noise characteristics of the dataset prior to analysis. A previous study reported on the effectiveness of various clustering techniques using statistically established cluster validity measures on simulated and hybrid datasets. This study demonstrates that using additional processing methods such as spectral peaks dataset partitioning, cluster merging, and spatial-temporal region growing leads to faster and more robust data processing and results in higher validity measures for exploratory data analysis when using fuzzy clustering.

The use of PCA to reduce the dimension of fMRI datasets prior to ICA has been shown to have a significant effect upon the sources extracted. We have provided simulations using resting-state data and added sources either from real data or artificial data where the sources were parameterized by a general exponential power distribution. Our results show that a PCA reduction can be beneficial for strong sources and provide better source estimates. But PCA preprocessing can also be detrimental if the activation is weak. We introduce a modified ROC method to compare different source estimates at any threshold.

Connectivity analyses of functional data frequently neglect behavioral measures of learning by only using these data to define learning periods. We propose a behavior-driven approach for data analysis that integrates behavioral and functional data, thus allowing direct connectivity analyses of dynamic cognitive processes. Using a motor learning task and the WICA seeding method, we found a strong negative correlation between decreasing reaction time and increasing activation of regions mediating motor learning (cerebellum, basal ganglia, prefrontal cortex). The inclusion of behavioral data allows comprehensive functional explorations of the temporally dynamic interactions between these neural regions during motor learning.

Merged ensemble clustering (MEC) is proposed as an unsupervised explorative data analysis (EDA) method that provides a single final cluster result which represents the true activation better than the individual cluster results. It thereby reduces the instability induced by the clustering method and corresponding parameter choice. The application of pluralistic strategies was already proposed for fMRI analysis, however, no thorough studies have been performed up to now to find the appropriate approach. Both methods presented (Voting-Merging and Bagged Clustering) obtain very good results, but the VM method performs better at low CNR.
13:37 1089  Solving the Multiple Comparison Problem in fMRI using a Method Based on Bootstrapping the Order Statistics of the Resting State Data
Rajesh Ranjan Nandy1, Dietmar Cordes1
1University of Washington, Seattle, Washington, USA

The multiple comparison problem has always been challenging in fMRI due to the complex nature of spatial dependence among neighboring voxels. A conservative solution is the Bonferroni correction which works well when the hypotheses are independent, but is too conservative for fMRI data analysis. A better approach is the Gaussian random field approach, but it makes several strong assumptions, the validity of which cannot always be justified. Here we propose a new method based on bootstrapping the Order Statistics for the resting state data to estimate the distribution of the maximum statistic which immediately solves the multiple comparison problem.

13:38 1090  Investigating Drug-induced Seizures in Rats using BOLD-fMRI and Cluster Analysis
Larissa I. Stanberry1, Bart P. Keogh1, Rajesh R. Nandy1, Dietmar Cordes1, Kenneth Maravilla1
1University of Washington, Seattle, Washington, USA

Drug-induced seizures in an animal (rat) model were studied to identify brain regions with similar responses using Hierarchical Clustering combined with Dendrogram Sharpening. Clustering algorithm identifies biologically distinct seizure events by producing multiple clusters with unique time courses in case of gradual onset, and clusters with identical time-courses in case of synchronous activation. Obtained clusters strongly correlate with anatomic boundaries. These results demonstrate the usefulness of our clustering method in the analysis of seizure events.

13:39 1091  A Potential Application of Incremental Analysis in Offline Processing of Functional MRI Data
Epifanio Bagarinao1, Kayako Matsuo1, Toshihito Nakai1
1National Institute of Advanced Industrial Science and Technology, Ikeda City, Osaka, Japan

Incremental analysis, a technique in which each image volume is incorporated into the analysis one after the other and popularly used in real-time functional MRI, is used in offline processing to detect temporally local effects of sudden head movements. The contribution of each newly added image volume in the final activation map is assessed. The results of an analysis of an fMRI data set showed that incremental analysis could be used to assess the effectiveness of realignment as a tool for motion correction, which is critical for instance in clinical studies with uncooperative patients.

13:40 1092  Automatic Model Selection Scheme for GLM-based Functional MRI Analysis
Epifanio Bagarinao1, Kayako Matsuo1, Toshihito Nakai1
1National Institute of Advanced Industrial Science and Technology, Ikeda City, Osaka, Japan

An automatic model selection scheme is applied to the analysis of functional MRI data. The method is based on an orthogonalization procedure where explanatory variables are first transformed into orthogonal basis functions. The estimation process and statistical assessment are carried out in the transformed space. The significance of each term is assessed using the estimated coefficients and the number of terms to be included in the final model is determined using an information criterion. Instead of finding an optimal simultaneous model for all voxels, the method searches for a parsimonious model on the voxel level.

13:41 1093  Analysis of Simultaneous fMRI and EEG Data: A Validation Study
Anthony B. Waites1, Marnie Shaw1, Regula S. Briellmann1, Angelo Labate1, Richard Masterton1, Graeme D. Jackson1
1Brain Research Institute, Melbourne, Australia

Simultaneous functional magnetic resonance (fMRI) images and electroencephalograms (EEG) is used to explore the localisation of electrical discharges in epilepsy. It remains untested whether results are sensitive to the approach chosen to handle ambiguous EEG trace signals. In the present study we find that the robustness of the results (measured using number of false positives, as well as maximum statistic) is quite sensitive to such choices. We conclude that an approach where artefactual, motion related events are removed from the data, and a flexible model of the BOLD response applied, yield more significant results with lower false positive rates.

13:42 1094  Inter-Scan Motion Correction in fMRI. Direct k-space Determination of the 3D Rotation Parameters
Mathilde Pachot-Clouard1, Christoph Segebarth1, Michel Décorps1
1CHU, Grenoble, Isère, France

A 3D image co-registration algorithm in k-space, capable of determining small rotation angles directly, has been developed. The algorithm reduces the determination of the 3D rotation parameters to that of three in-plane rotations. Monte-Carlo experiments have indicated that the method permits accurate estimation of the rotation parameters and that it is robust with respect to the noise. Iteration of the method allows determination of large rotation angles.
Brandon R. Logan1, Daniel B. Rowe2
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Single-subject fMRI experiments identify active voxels by performing individual voxelwise tests of the hypothesis that the observed time course is not significantly related to an assigned reference function. The test statistics are thresholded so that those voxels whose test statistic exceeds the threshold are viewed as active. This study describes three error rates which may be used to formally set activation thresholds for fMRI data, reviews methods for determining these thresholding rules including incorporation of spatial correlation information, illustrates the application of these methods on a real dataset, and discusses relative performance of the three procedures in simulations.

Richard D. Hoge1, Anthony Lisso1
1A.A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA

Using object-oriented design techniques, we have developed an application for image visualization and analysis offering a high degree of flexibility and interactivity, as well as high performance through the use of digital signal processing hardware available on a moderately priced consumer-oriented computer system.

13:45 1097. Modeling of the Spatial Covariance Structure of the Brain using Variograms with a Non-Euclidean Metric
Rajesh Ranjan Nandy1, Yulia Gel2, Dietmar Cordes1
1University of Washington, Seattle, Washington, USA; 2George Washington University, Washington, District of Columbia, USA

Modeling the spatial dependence among the voxels in the brain is an important problem in MR/ fMRI. However, the problem is nontrivial primarily due to the fact that the physical characteristics of the three primary constituents of the brain (gray matter, white matter and CSF) are quite different. A natural choice is a segmentation based approach to isolate gray matter, white matter and CSF. However, this creates additional problems as all the individual segments are not simply connected (which means there may be holes inside the segments). We propose the use of a non-Euclidean distance function to circumvent the problem.

Yulia Gel1, Rajesh Ranjan Nandy2, Dietmar Cordes1, Todd Richards2, Virginia Berninger2
1George Washington University, Washington, District of Columbia, USA; 2University of Washington, Seattle, Washington, USA

Characterization of spatial dependency in MR and fMRI data is an important problem which is beneficial to the pre/post-processing of the data. As a preliminary approach, we ignore the temporal evolution of the fMRI data and only investigate the spatial dependency of structural MR data using tools from geostatistics. Since the physical characteristics of the three primary constituents of the brain (gray matter, white matter and CSF) are quite different, we adopt a segmentation based approach and analyze each constituent separately. The proposed method may be extended to fMRI data to do a full spatio-temporal modeling.

Sherman Jordan Kisner1, Tie-Qiang Li2, Yang Wang1, Thomas Talavage1, Vincent Mathews2, William Kronenberger3, David Dunn2
1Purdue University, West Lafayette, Indiana, USA; 2Indiana University School of Medicine, Indianapolis, Indiana, USA

Signal fluctuations in gradient echo images have been used to map regions of the resting brain with slow but synchronous variations in blood flow and oxygenation levels. It has previously been shown that such temporal coherence is associated with functionally connected brain regions. In this study, we develop a clustering strategy to quantitatively assess differences in this type of functional connectivity between individuals. The proposed measures of connectivity include spatial extent and connective “strength”. The method is applied to a study of adolescents with disruptive behavior disorders by comparing their connectivity maps with those in matched control subjects.

Brandon Whitcher1, Adam J. Schwarz2, Herve Barjat3, Sean C. Smart1, Robert I. Grundy3, Michael F. James3
1GlaxoSmithKline, Harlow, UK; 2GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; 3GlaxoSmithKline Neurology and Gastrointestinal Centre of Excellence for Drug Discovery, Harlow, UK

Data-driven methods have begun to be applied to fMRI data, and are likely to prove valuable in highlighting spatio-temporal patterns in pharmacological MRI (phMRI) and other time series data as well. The Wavelet-based Cluster Analysis (WCA) algorithm finds clusters of voxels based on the coefficients of a discrete wavelet transform of the time courses. Applied to cocaine-challenge phMRI data WCA distinguished the subtly different temporal responses of different brain regions. Applied to perfusion-weighted data WCA differentiated healthy tissue and different regions within the damaged contralateral hemisphere, highlighting differences in cerebral perfusion.
ICA-Based Spatial Filters to Reduce Cardioballistic Noises in EEG Signals Acquired Inside the MRI Magnet

Jae Yong Han¹, Hang Ro Lee¹, Soo Yeol Lee¹, Young Hwan Choi¹, Jae Gon Kim¹
¹Kyung Hee University, Yongin, Kyungki, Republic of Korea

Cardioballistic noises in the EEG data measured inside the magnet are very troublesome in combinatory studies of EEG and fMRI. We used the ICA method to reduce cardioballistic noises in the EEG data measured inside a 3.0 Tesla MRI magnet. With the spatial filter that was constructed through ICA during the preparatory period, we have successfully reduced cardioballistic noises in the EEG data measured later on in a real time processing mode. It has been found that the proposed technique is more robust to temporal variations in the cardioballistic waveform than the conventional averaging method.

A Randomization Test for Non-Parametric Inference of Filtered FMRI Time-Series Data

K Gopinath¹, B Crosson¹, K Peck¹, A Moore¹, K White¹, R Briggs¹
¹University of Florida, Gainesville, Florida, USA

Some FMRI studies, e.g. task-locked FMRI of patients, suffer from low FMRI signal-to-noise ratios because of the sparseness of the relevant brain activation events. Filtering sparse event FMRI time-series will lead to an increase in SNR, but at the expense of loss of gaussian noise properties. This renders the task of making parametric inferences very difficult. In this study, a randomization test to help make nonparametric inference of filtered FMRI time-series data is introduced. The results of application of this method to the language FMRI dataset of an aphasic patient are presented.

Analysis of the Spatial Specificity of Canonical Correlation Analysis in fMRI

Rajesh Ranjan NANDY¹, Dietmar Cordes²
¹University of Washington, Seattle, Washington, USA

Canonical correlation analysis (CCA), a multivariate statistical method, has become popular in fMRI in recent times. In its conventional form, it suffers from a severe weakness related to the assignment of fMRI activation to the center voxel among a group of voxels of interest. To rectify this, a novel assignment scheme, which is adaptive and dynamic in nature, has been proposed previously. Here we perform an analysis of the effects of adaptive CCA scheme using fMRI data. The results clearly demonstrate that this new assignment scheme is a vast improvement over the conventional scheme of assigning to the center voxel.

Multivariate Analysis of EEG-Correlated fMRI

Marnie Shaw¹, Anthony Waites², Regina Briellmann², Richard Masterton², Angelo Labate², Stephen Strother³, Graeme Jackson²
¹Brain Sciences Institute, Melbourne, Australia; ²Brain Research Institute, Melbourne, Victoria, Australia; ³University of Minnesota, Minneapolis, Minnesota, USA

It is now possible to acquire electroencephalographic (EEG) data during functional magnetic resonance imaging (fMRI) experiments and several groups are using this new technology to study EEG specific phenomena such as sleep patterns and epileptic disorders. Due to unresolved data analytic issues, however, results of these studies may have increased false positive and false negative rates. Based on a comparison analysis of our fMRI experiment, we conclude that an alternative analysis method (multivariate) we used was effective in capturing more information about interictal brain activity that was observed with a standard analysis approach.

Maximized Mutual Information: A Novel Approach for Brain Activation Detection in fMRI

Shunshan Li¹, Song Lai¹, Xiaoyin Xu¹, Jianrong Shi¹, John P. Lackey¹
¹Thomas Jefferson University, Philadelphia, Pennsylvania, USA

Mutual Information (MI) has been widely used in medical informatics, especially in image realignment. In this study, we investigated its utilization in fMRI brain activation detection. Both computer simulations and finger tapping activation studies were carried out to assess the characteristics of MI. Simulation results suggested that the MI of two time course signals is highly sensitive to their degree of similarity in timing. Thus, maximization of MI (MMI) by temporal shifting was applied to improve fMRI activation detection. In each finger tapping experiment, activation signals were reliably detected, suggesting that MMI represents an alternative approach for fMRI activation detection.

Increase in Refractoriness of the BOLD Response Along a Functionally Connected Neural Pathway

K Gopinath¹, K Peck¹, T Conway¹, R Briggs¹
¹University of Florida, Gainesville, Florida, USA

Refractoriness of BOLD hemodynamic response functions (HRFs) at short inter-stimulus intervals (ISIs) has been observed in prior fMRI studies primary visual, auditory and motor cortices as well as at slightly longer ISIs in higher level cognitive areas (medial frontal gyrus). In this study, the change in the refractoriness of the BOLD HRF along the receptive and expressive language-processing network was examined. Preliminary results provide strong evidence that the non-linearity of the BOLD response increases along this functionally connected neural pathway.
fMRI in Animals: Physiology and Pathophysiology

Room H  Monday 14:00 - 16:00

14:00  1107. Imaging the Neural Pathways Activated by Oral Ecstasy (MDMA) In Conscious Marmoset Monkeys.
Matthew E. Brevard1, Jerrold S. Meyer2, Craig F. Ferris2
1University of Massachusetts Medical School, Worcester, Massachusetts, USA; 2University of Massachusetts, Amherst, Massachusetts, USA

MDMA is an increasingly popular drug of abuse, with little known about the functional effects it has on the brain. As part of an ongoing MRI study of the effects of MDMA in a relevant model, we investigated the acute effects of MDMA in nonhuman primates. Robust and mostly non-cortical activations occurred 5 min. after MDMA. The response to visual stimulation also increased after the drug was administered.

14:01  1108. Mapping of Cholinergic Muscarinic Receptor Activation with Pharmacological MRI
Erik Hoff1, Robert van Oostenbrugge1, Jet van der Zijden2, Ona Wu2, Annette van der Toorn2, Harry Steinbusch3, Rick Duikhuizen2
1University Hospital Maastricht, Maastricht, Netherlands; 2Image Sciences Institute, Utrecht, Netherlands; 3EURON, Maastricht, Netherlands

The cholinergic system is implicated in many functional and pathological states. In the current project, we applied pharmacological MRI (phMRI) to assess cholinergic neuronal activity in vivo. Rats were intravenously injected with pilocarpine, a non-selective cholinergic muscarinic receptor agonist, which resulted in significant activation responses in basal forebrain, cortex, hippocampus and thalamus. This brain activation pattern corresponds to cholinergic muscarinic receptor distribution in rat brain.

14:02  1109. Increased Plasma Sodium Induced Neural Activations in the Hypothalamus: An fMRI Study
Mohsen Dashti1, John Williams1, Moshi Geso2, Gary Egan1, Brett Purcell1, Peta Burns1, Richard Weisinger2
1The Howard Florey Institute of Experimental Physiology and Medicine, Melbourne, Victoria, Australia; 2Royal Melbourne Institute of Technology (RMIT) University, Bundoora, Victoria, Australia

We utilised EPI based-fMRI to determine the brain regions influenced by changes in blood sodium concentration, using an IV hypertonic saline infusion. All experiments showed a significant increase in BOLD signal, particularly in the thalamus and the hypothalamus. Dividing the entire fMRI period up into defined time series allowed increased sensitivity to activations produced by a slowly changing physiological variable. The brain areas that showed activation are known to be involved in the regulation of thirst as shown in experiments utilising lesion and c-Fos techniques.

14:03  1110. GABA Re-uptake Inhibitor Trigged Neuronal Cascading Effect Detected by fMRI
Guofan Xu1, Yin Xu1, Gaohong Wu1, Feng Luo1, Shi-Jiang Li1
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

BOLD fMRI methods were used to study the temporal and spatial signal changes in rat brain induced by NO-711 hydrochloride, a potent Gamma-aminobutyric acid (GABA) reuptake inhibitor. Upon administration of NO-711, BOLD signal changes were detected in nucleus accumbens (NAc), thalamus subsequently, and in the frontal cortex regions. These BOLD signal changes demonstrated an inter-correlated temporal and spatial nature among regions in NAc, Thalamus, and cortices. It is suggested that BOLD fMRI could be used to detected neuronal cascading effect induced by drug, which could help to elucidate the neuronal circuits in a systemic level.

14:04  1111. Functional Mapping of Intracerebroventricular (ICV) Infusion of Neuroactive Compounds in the Anaesthetised Rat
Alessandro Gozzi1, Adam J. Schwarz1, Torsten Reese1, Valerio Crestan2, Simone Bertani2, Giuliano Turri2, Mauro A. Corsi1, Angelo Bifone1
1GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; 2GlaxoSmithKline, Verona, Italy

Pharmacological MRI (phMRI) methods have been applied to study brain activity induced by psychoactive drugs like cocaine and amphetamine. However, the use of phMRI to investigate the central activity of neuropeptides has been limited by the poor brain penetration of these compounds, and by the confounding effects associated with their peripheral activity. We have developed methodology to study the phMRI response to intracerebroventricular (ICV) acute challenge with neuroactive compounds. This protocol has been applied to investigate, for the first time, the haemodynamic effects elicited by central infusion of Substance P, a peptidic neurotransmitter of the tachikynin family.
14:05  1112. Functional Imaging of Intracerebroventricular Injection of Corticotropin-Releasing Factor (CRF) in the Anaesthetised Rat

Alessandro Gozzi1, Adam J. Schwarz2, Torsten Reese1, Valerio Crestan2, Simone Bertani2, Giuliano Turrini2, Emilio V. Merlo-Pich1, Jim J. Hagan1, Angelo Bifone1
1GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; 2GlaxoSmithKline, Verona, Italy

Central administration of Corticotropin-releasing factor (CRF) in the rat is a tool to study the behavioural and neurochemical effects of this peptide, and to probe the action of specific antagonists of CRF receptors. However, the specific brain structures on which the CRF exerts its activity are still to be elucidated. We have investigated the fMRI response to intracerebroventricular (ICV) challenge of CRF in the anaesthetised rat. A significant cardiovascular response consistent with a central activity of CRF was observed. FMRI response was localised in the periventricular region of the diencephalon, a region rich in CRF2 receptors.

14:06  1113. Investigation of the BOLD Response in the Rat’s Visual System using a Visual Flash Stimulus

Nadja Van Camp1, Marleen Verhoye1, Annemie Van der Linden1
1University of Antwerp, Wilrijk, Antwerp, Belgium

We investigated the temporal distinguishing capacity of the rat’s visual system during uni- and bilateral stroboscopic flash stimulation, by studying the BOLD response in the superior colliculus (SC) and the visual cortex (VC). In contrast to the VC, the SC was most sensitive to high frequencies (8-12Hz), habituated significantly to repeated optimal frequency stimulations, displayed a higher flicker fusion frequency (50 Hz) and generated a larger BOLD contrast. Stimulation of only one eye caused a decreased BOLD response in the SC but different optimal response frequencies in the VC.

14:07  1114. 3D CBV-Weighted Functional MRI of the Rat Brain with High Spatial and Temporal Resolution Using Half-Fourier Gradient Echo EPI

Shella Dawn Keilholz1, Afonso C. Silva1, Alan P. Koretsky1
1National Institutes of Health, Bethesda, Maryland, USA

Whole-brain fMRI of the rodent with high spatial and temporal resolution has the potential to provide information about functional neural networks. Using a gradient echo 3D EPI sequence with half-Fourier reconstruction, functional images with CBV contrast were obtained in rats at 11.7T during stimulation of the forepaw. Spatial resolution was 300 x 300 x 800 microns, and the entire brain was imaged every 3 seconds. Activation was observed in SI, thalamus, and cerebellum. The high contrast to noise of this sequence (~20% change in SI) provides great sensitivity to activation in small areas of the brain.

14:08  1115. Observation of Neural Activity in Crayfish with Mn-Enhanced MRI

Xiaodong Zhang1, Jens Herberholz2, Christopher J. Mims3, Donald H. Edwards2, Xiaoping Hu1
1Georgia Tech / Emory University, Atlanta, Georgia, USA; 2Georgia State University, Atlanta, Georgia, USA

Manganese-enhanced MRI (MEMRI) is a sensitive tool for observing calcium-dependent neuronal activity. Manganese is transported trans-synaptically, and can be used to trace connections within the brain. In this study, MEMRI was used on adult crayfish (Procambarus clarkii). Manganese enhancement was observed in the crayfish brain after unilateral stimulation of the antennules. The results demonstrate the effectiveness of MEMRI as a way to map neural activity in crayfish.

14:09  1116. Systemic Effects of Anesthesia on the fMRI-BOLD Signal Response During Apnea in Rats

Sridhar S. Kannurpatti1, Bharat B. Biswal2
1UMDNJ-New Jersey Medical School, Newark, New Jersey, USA

Urethane anesthesia does not influence GABAergic mechanisms involved in the control of cardiovascular functions unlike pentobarbital. We hypothesized that pentobarbital and urethane would have distinct systemic effects during apnea. Their influence on the MAP, CBF and the fMRI-BOLD signal dynamics was studied in rats using fMRI and laser Doppler flowmetry. Pentobarbital anesthesia had a significantly different effect with respect to BOLD signal onset time, percent change in CBF and MAP when compared to urethane. Anesthesia-dependent MAP change modulated the apnea-induced CBF response but had a minimal effect on the fMRI-BOLD signal probably due to uncoupling of CBF and oxygen consumption.

14:10  1117. Comparing fMRI of the Rat Spinal Cord in the Alpha-Chloralose and Halothane Anesthetized Rat during Electrical Forepaw Stimulation

Jane M. Lawrence1, Patrick W. Stroman1, Marco L.H. Gruwel1, Saro Bascaramurty2, Allan Turner2, Kris L. Maliszewski1
1University of Manitoba, Winnipeg, Manitoba, Canada; 2National Research Council Institute for Biodiagnostics, Winnipeg, Manitoba, Canada

Functional Magnetic Resonance Imaging (fMRI) in animal models is complicated by the requirement of anesthesia. The effects of anesthetics on functional activation have been examined in the brain but not yet in the spinal cord. Rats were anesthetized with halothane or alpha-chloralose and imaged at 7 Tesla. Functional activation was observed in physiologically relevant regions of the spinal cord in both groups of rats. Presence of neuronal activation was verified in both groups by immunohistochemistry.
14:11 1118. Correspondence of fMRI and 2-Deoxyglucose Representations of the Rodent Forepaw in Primary Somatosensory Cortex under Different Anaesthetics
Aisling Lisa Dixon1, Diana Cash1, Steven Charles Williams1, Gerald Thomas Finnerty1
1Institute of Psychiatry, London, UK

Functional MRI can be used to image cortical maps non-invasively. We studied the BOLD and 2-deoxyglucose representations of the rodent forepaw using different anaesthetics. Under chloralose anaesthesia, unilateral forepaw stimulation evoked a positive BOLD response in contralateral primary somatosensory cortex and negative BOLD in ipsilateral somatosensory cortex. The spatial extent of the positive BOLD response was congruent with forepaw maps generated by 14C-deoxyglucose. In contrast, we found that the BOLD response in the cortex evoked by unilateral forepaw stimulation was attenuated by the volatile anaesthetics, isofluorane and sevofluorane. This suggests that anaesthesia is an important determinant of fMRI-generated maps.

14:12 1119. Quantitative Regional Cerebral Blood Flow Differences in Normal and Attention-Deficit/Hyperactivity Disorder Rats
Jared Danker1, Zhaohui M. Liu1, Timothy Q. Duong1
1University of Massachusetts Medical School, Worcester, Massachusetts, USA

Regional changes in cerebral blood flow (CBF), tissue volume and cognitive functions have been reported in humans with attention-deficit/hyperactivity disorder (ADHD). In this study, we investigated high-resolution quantitative CBF in a well-established rat model (SHR rats) of attention-deficit/hyperactivity disorder (ADHD) compared to well-established control (WKY) rats. The accuracy of repeated CBF measurements within and across different animals was carefully evaluated. CBF differences between ADHD and control rats were analyzed for the medial prefrontal cortex, caudate nucleus, globus pallidus, frontal cortex, sensory cortex, motor cortex, thalamus, hippocampus, and whole brain.

14:13 1120. fMRI of Absence Seizures in Marmoset Monkeys
Jeffrey R. Tenney1, Mathew E. Brevard1, Jean A. King1, Craig F. Ferris1
1University of Massachusetts Medical School, Worcester, Massachusetts, USA

Absence epilepsy is characterized by generalized seizures consisting of multiple, brief impairments of consciousness. Absences are unique among seizure types due to their pharmacologic treatments and characteristic bilaterally synchronous 3 Hz spike and wave discharges (SWD) on EEG. Rodent models of the disorder have SWDs of 7-8 Hz, while those of humans are 3 Hz. EEG studies in rhesus monkeys have indicated that non-human primates also present with 3 Hz SWD during absence seizures. fMRI studies in common marmoset primates will extend our understanding of the central mechanisms contributing to absence epilepsy with the hope of developing better drug treatments.

Pathophysiological and Clinical Aspects of fMRI

Room H  Tuesday 13:30 - 15:30

13:30 1121. Acute Optic Neuritis – A Follow-up MRI and Functional MRI Study
Achim Gass1, Chuh-Hyoun Lie2, Dieter Braus1, Jochen Hirsch4, Matthias Ruf1, Fritz A. Henn5, Michael Hennerici1
1Universitätsklinikum Mannheim, Mannheim, Germany; 2Forschungszentrum, Juelich, Germany; 3Universitätsklinik Hamburg Eppendorf, Hamburg, Germany; 4Universitätskliniken Kantonsstital, Basel, Switzerland; 5Zentralinstitut für Seelische Gesundheit, Mannheim, Germany

In optic neuritis data regarding the consequences of the conduction delay on cortical activation, and concerning mechanisms of adaptation and plasticity in the recovery process are rare. We examined patients with ON serially along their clinical recovery. The conduction disturbance in patients with ON is associated with a reduced cortical BOLD response, which is normalising as part of the clinical and VER recovery. Additional extra-occipital areas may be activated in late recovery phase.

Stephan Ulmer1, Friederike Moeller1, Stephan Wolff1, Ulrich Stephani1, Olav Jansen2
1Institute of Radiology, Luebeck, Germany; 2Section of Neuroradiology, Kiel, Germany

Periventricular leucaenphalopathy (PVL) is a prenatal disorder of the early last trimenon of gestation causing motor disabilities of various degree. Using fMRI we correlated the extent of clinical disability with functional imaging findings and morphometric correlates and elucidated mechanisms of cortical reorganization. There was a good correlation between lesion size and testing scores with small lesions demonstrating significantly better clinical outcome. Good clinical outcome was associated with additional recruitment of premotor areas in mapping of the affected hand. There seems to be a need for this activation beside M1 to compensate for motor abilities in these patients.
13:32  **1123. Effect of Acupuncture on Carpal Tunnel Syndrome with fMRI Assessment of Cortical Somatotopy**

Vitaly Napadow¹, Jing Liu¹, Angela Ryan¹, Ming Li¹, Ken K. Kwong¹, Norman Kettner³, Joseph Audette², Kathleen K.S. Hui¹

¹Massachusetts General Hospital, Charlestown, Massachusetts, USA; ²Spaulding Rehabilitation Hospital, Medford, Massachusetts, USA; ³Logan College of Chiropractic, Chesterfield, Missouri, USA

The mechanisms underlying somatotopic reorganization following peripheral nerve injury are poorly understood and the benefits of alternative treatment have received limited study. We investigated finger somatotopy in chronic carpal tunnel syndrome (CTS), the most common entrapment neuropathy. Clinically and electrophysiologically confirmed CTS patients and non-effected subjects received 100Hz innocuous electrical stimulation at the 2nd, 3rd and 5th digits in conjunction with fMRI. We used cortical based methods to analyze the fMRI data. Patients were then entered into a 5 week acupuncture treatment protocol. Post-treatment, the clinical, electrophysiological and fMRI data were again recorded.

13:33  **1124. The Effect of Nicotine on the BOLD MRI Response in Smokers**

Harald Bruhn¹, Manfred Brauer², Klaus-Dietmar Merboldt³, Jens Frahm³

¹Charité-CVK, Berlin, Germany; ²University of Guelph, Guelph, Ontario, Canada; ³Biomedizinische NMR ForschungsGmbH, Göttingen, Germany

The effect of nicotine on BOLD MRI responses was measured in habitual smokers. A standardized protocol of repetitive and sustained visual stimulation was followed to measure the nicotine effect on the physiologic BOLD response employing EPI at 2.0-T. At both stimuli nicotine increased the number of activated voxels by up to 110% while the normalized response amplitude decreased by up to 50% due to vasoconstriction. Moreover, no significant BOLD activation could be found at peak serum levels of nicotine (2-5 min p.i.) in specific deep limbic cortical structures.

13:34  **1125. Reorganization of the Cortical Control of Movement due to Radiation Necrosis: Evidence from fMRI of the Supplementary Motor Area.**

Bob L. Hou¹, Andrei Holodny¹, Jazmin Schwartz¹, Nathan Cooperman¹, Philip H. Gatin¹

¹MSKCC, New York, USA

Publications have demonstrated cortical reorganization due to tumor invasion of the primary motor cortex (PMC) by showing an increase in activation in the ipsilateral supplementary motor area (SMA). A patient with unilateral radiation necrosis extending into the PMC, but not the SMA, had greater BOLD fMRI activation in the SMA on the side with the radiation necrosis for all r-values (p < 0.017). This implies that as radiation necrosis damages the PMC, the SMA takes on a more active role in the cortical control of movement, possibly including some of the function of the PMC.

13:35  **1126. Spinal fMRI of Multiple Sclerosis in Human Subjects**

Amanda D. Bergman¹, Corinne LeBlanc², Patrick W. Stroman³

¹University of Manitoba, Winnipeg, Manitoba, Canada; ²Health Sciences Centre, Winnipeg, Manitoba, Canada; ³National Research Council, Winnipeg, Manitoba, Canada

Spinal fMRI has been shown to detect activity in the gray matter of the spinal cord of healthy subjects as well as subjects with a spinal cord injury. We present the first spinal fMRI study of patients with multiple sclerosis as it pertains to the patterns of activity observed. Neuronal activity was consistently detected in the grey matter of the spinal cord of these patients with the pattern of activity altered with the presence of a motor or sensory deficit. These results suggest that spinal fMRI has potential as a tool for assessment of patients with clinical or suspected MS.

13:36  **1127. Cortical Activation During Visual Masking in Migraine With Aura**

Jie Huang¹, Mark DeLano¹, Yue Cao²

¹Michigan State University, East Lansing, Michigan, USA; ²University of Michigan, Ann Arbor, Michigan, USA

We investigated cortical activation during visual masking in migraine patients with aura. The decreased visibility of a visual target was found to be associated with a reduction in cortical activation, and no significant difference was observed between migraine patients with aura and non-headache controls.

13:37  **1128. Event -Related fMRI in the Study of Pathogenesis of Paroxysmal Trigeminal Neuralgias: A Case Study**

Valeria Blasi¹, Alberto Bizzi², Massimo Leone², Angelo Franzini², Domenico D’Amico², Andrea Falini², Gennaro Bussone²

¹Università Vita-Salute San Raffaele, Milano, Italy; ²Istituto Neurologico Besta, Milano, Italy

A 64 y-o patient with short-lasting unilateral neuralgiform pain with conjunctival injection and tearing (SUNCT) has been investigated with an event-related fMRI paradigm. The patient was asked to press a button at facial pain onset and cessation. fMRI data showed activation in L cerebellum, in R vermis, R middle temporal gyrus, L superior temporal gyrus (BA22), bilateral medial thalamus and posterior hypothalamus, L lenticular nucleus, L precentral gyrus, anterior cingulate and SMA. Event-related fMRI allowed us to determine a complex pattern of brain activity involved in the pathogenesis of SUNCT.
This FMRI study relates cocaine-induced functional response in the lower brain to time series of "high" and "craving" ratings, which were supplied by the subjects during the experiment. Cocaine-induced euphoria and craving are demonstrated to be separate conscious processes that are feasibly differentiated by multiple regression of BOLD data. The MESBAC pulse sequence was used to acquire FMRI data in the presence of severe susceptibility gradients in the areas of interest, including the nucleus accumbens, ventral tegmentum and orbitofrontal cortex.

fMRI: Primary Sensory and Motor Activation

Room H  Monday 14:00 - 16:00

14:00  **1130. Conscious Perception of Visual Objects: The role of Premotor Cortex**  
**Stephanie Lehericy**, **Pierre-Francois Van de Moortele**, **Leon Tremblay**, **Kamil Ugurbil**, **Dae-Shik Kim**  
1University of Minnesota, Minneapolis, Minnesota, USA; 2Hopital de la Salpetriere, Paris, France; 3Boston University School of Medicine, Boston, Massachusetts, USA

We have investigated passive visual object perception using fMRI. The focus is on the involvement of the premotor cortex, which we believe is important for human consciousness. We believe this study supports a theory of consciousness as simulations of movement below a threshold for actual movement. Furthermore this present study has shown the involvement of the ventrolateral nucleus of the thalamus and the dentate nucleus of the cerebellum in early motor execution dependent on which hand to use.

14:01  **1131. Functional Anatomy of the Observation and Imagination of Unimanual and Bimanual Actions**  
**David Kingsley**, **Arshad Zaman**, **Elizabeth Franz**, **Neil Roberts**  
1University of Liverpool, Liverpool, UK; 2University of Otago, Dunedin, New Zealand

Previous studies have found neural overlap between execution, action observation and imagination of motor actions. “Mirror neurons” (MNs), in Broca’s area in the inferior frontal gyrus, may particularly link such motor-related tasks by forming internal representations of actions. This study examined bimanual and unimanual observation and imagination, using ecologically-valid goal-directed hand movements as stimuli deemed likely to elicit MN (IFG) activity. Unimanual action observation produced left-sided IFG activity, whereas bimanual action observation showed bilateral IFG activation. This suggests that MNs may be activated bilaterally in the formation of representations of bimanual actions.

14:02  **1132. Overlapping Neural Representation in the Control of Lingual and Hand Movements**  
**Jazmin Schwartz**, **Kristine Mosier**, **Nicole Petrovich**, **Andrei I. Holodny**, **Dennis Kraus**, **Hilda Stambuck**  
1Memorial Sloan-Kettering Cancer Center, New York, New York, USA; 2Indiana University School of Medicine, Indianapolis, Indiana, USA

Previous investigation of swallowing described cortical networks active during swallowing that shared many features with those described for object manipulation by the hands. This investigation sought to determine whether shared neural substrates exist for sensorimotor tasks involving the same motor demand but executed by effectors with different biomechanical properties. Five healthy subjects performed two hand movement tasks, a tongue-tapping task and a swallowing task while imaged using fMRI. Results suggest cortical representation of movements by biomechanically different effectors shares a network involving sensorimotor, premotor and parietal cortex and the cerebellum.

14:03  **1133. Differential Involvement of the Striatum in the Control of Sequential Movement Complexity**  
**Stephanie Lehericy**, **Piero-Van de Moortele**, **Leon Tremblay**, **Kamil Ugurbil**, **Dae-Shik Kim**  
1University of Minnesota, Minneapolis, Minnesota, USA; 2Hopital de la Salpetriere, Paris, France; 3Boston University School of Medicine, Boston, Massachusetts, USA

In this study, we tested the hypothesis that increased complexity of sequences of finger movement would recruit anterior parts of the striatum. Eight healthy volunteers were studied using fMRI at 3T. Results showed that the posterior part of the putamen was activated during all movements. Simple sequencing induced recruitment of the anterior putamen, and the complex sequence task was associated with further recruitment of bilateral caudate nuclei.

14:04  **1134. Effect of Electric Stimulus Frequency on the Activation of the Secondary Somatosensory Cortex in BOLD fMRI**  
**Cosimo Del Gratta**, **Antonio Ferretti**, **Claudio Babiloni**, **Massimo Caulo**, **Armando Tartaro**, **Paolo Maria Rossini**, **Gian Luca Romani**  
1Università G D’Annunzio, Chieti, Italy; 2Fondazione Università D’Annunzio, Chieti, Italy; 3Università La Sapienza, Roma, Italy; 4Università Campus Biomedico, Roma, Italy

Previous evidence indicates that SI presents an increase of the BOLD response with increasing stimulation frequency in the range 5-100 Hz. The present study aims at investigating the BOLD response of SI and SII during the stimulation of the median nerve at frequencies in the range 0.5 Hz to 4 Hz. The BOLD response increased in amplitude and spatial extension in SI and contralateral SII at the highest compared to the lowest stimulation frequency, but did not increase in the ipsilateral SII. To our knowledge this is the first case in which an asymmetry in the SII cortices is observed.
14:05  **1135.** Timecourse of Visual and Motor Activation during Observation and Self-Selection of Action using Rapid Event-Related fMRI

Ross Cunnington, Christian Windischberger, Ewald Moser
1University of Melbourne, Melbourne, Australia; 2University of Vienna, Vienna, Austria

Observation of action involves activation of motor areas normally involved in the control of movement. We examined differences between the observation of actions and the self-selection of action in 14 healthy subjects. Using rapid event-related fMRI and exploratory model-free analysis methods we could separately examine early activation associated with observation/self-selection of action from later activity associated with the execution of action. A common network of SMA, lateral prefrontal and superior parietal areas was involved in both tasks. Observation of action involved more extensive higher visual and inferior parietal activation, while self-selection involved significantly greater lateral prefrontal and anterior cingulate activation.

14:06  **1136.** Activation Changes of Sensomotor Brain Areas after Intake of Ethanol

Carsten Klingner, Johannes Bernarding
1Otto-von-Guericke University, Magdeburg, Germany

The influence of ethanol intake on the motor system was monitored with functional magnetic resonance imaging (fMRI). Activation of the dominant and the non-dominant hemisphere as well as synchronous activation was studied using a push button device. Different push button frequencies (1, 2, 3 Hz) were examined. Activation was stronger in the non-dominant hemisphere. After intake of alcohol a significant decrease of the activation was seen in the sensomotor cortex (SMC) with stronger attenuation in the non-dominant hemisphere. The supplementary motor area (SMA) exhibited a less significant activation decrease.

14:07  **1137.** The Dynamics of Ethanol Uptake in the Brain by Whole Brain MRSI, ADC Mapping and BOLD fMRI

Ulrike Dydak, Timothy P.L. Roberts, J. Michael Tyszka, Peter Boesiger, Howard Rowley
1University and ETH Zuerich, Zuerich, Switzerland; 2University of Toronto, Toronto, Ontario, Canada; 3Caltech, Pasadena, California, USA; 4University of Wisconsin, Madison, Wisconsin, USA

Recent improvements in RARE or turbo spectroscopic imaging (TSI) at 3T now allow whole brain data acquisition in approximately ten minutes. This enabled the use of spectroscopic imaging with large anatomical coverage to follow the dynamics of ethanol uptake in normal adult volunteers. TSI was interleaved with ADC mapping and BOLD fMRI to provide a broader picture of ethanol intoxication on the brain. Results demonstrate regional differences in detectable ethanol, slightly reduced ADC values in cerebrum and cerebellum, and BOLD signal loss during peak intoxication.

14:08  **1138.** Does Cortical Adaptation Change With Disease Evolution in MS? A Functional MRI Study of Patients With Different Disease Phenotypes.

Maria A. Rocca, Andrea Falini, Bruno Colombi, Angelo Ghezzi, Vittorio Martinelli, Giuseppe Scotti, Giancarlo Comi, Massimo Filippi
1Ospedale San Raffaele, Milan, Italy; 2Ospedale di Gallarate, Gallarate, Italy

This study shows that movement-associated cortical reorganization in multiple sclerosis (MS) varies with disease evolution. In the early stage of the disease, there is an increased recruitment of those areas "normally" devoted to the performance of a given task, such as the primary sensorimotor cortex and the supplementary motor area in case of motor tasks. At a later stage, bilateral activation of these regions is first seen, followed by a widespread recruitment of additional areas, which are usually recruited in normal people to perform novel/complex tasks.

14:09  **1139.** Does an Altered Pattern of Cortical Activations in Patients at Presentation With Clinically Isolated Syndromes Suggestive of MS Contribute to the Prediction of an Evolution to Clinically Definite MS?

Maria A. Rocca, Domenico M. Mezzapesa, Andrea Falini, Federica Agosta, Vittorio Martinelli, Angelo Ghezzi, Giuseppe Scotti, Giancarlo Comi, Massimo Filippi
1Ospedale San Raffaele, Milan, Italy; 2Ospedale di Gallarate, Gallarate, Italy

We followed up a group of patients with clinically isolated syndromes suggestive of MS for one year and compared the movement-associated pattern of activations, at disease onset, between patients with and without disease evolution. Compared to patients with disease evolution, those without evolution had an increased activation of several regions of the classic sensorimotor network. On the contrary, patients evolved to MS had increased activations of several regions in the frontal and parietal lobes, suggesting that in CIS patients, the assessment of the brain pattern of cortical activations should be considered among the factors predicting the subsequent disease evolution.
fMRI Applications: Language Function

Room H  Tuesday 13:30 - 15:30

13:30  1140. Gender Differences in Language Lateralisation
Gary Paul Liney\textsuperscript{1}, Roberto Garcia-Alvarez\textsuperscript{2}, Martin Pickles\textsuperscript{2}, Michal Lavidor\textsuperscript{2}, Lindsay Turnbull\textsuperscript{2}
\textsuperscript{1}University of Hull, Hull, UK

The routine demonstration of language lateralisation is an important goal of fMRI for the pre-surgical evaluation of patients in an attempt to replace invasive procedures such as WADA testing. This study has examined normal subjects with both a visually and aurally presented language task to reveal potential gender differences in these tests. Results demonstrate a clear left hemispheric dominance in male subjects for both lexical decision-making and auditory comprehension, while female subjects display a bilateral response to these tasks.

13:31  1141. Correlation Between LIP Activation and Interference Processing: An Event-Related fMRI Study
Heng Yi Rao\textsuperscript{1}, Yan Zhuo\textsuperscript{1}, Kai Zhong\textsuperscript{1}
\textsuperscript{1}Chinese Academy of Sciences, Beijing, People's Republic of China

Psychological tasks that required subjects respond to one information dimension of a stimulus and ignore other dimensions often produced interference between the task-irrelevant and task-required information processing. Event-related fMRI was used to identify the brain activations underlying three tasks vary in the source of interference: a Stroop word-color task, a spatial-orientation task and a spatial-word task. All tasks showed significant interferences between the two information dimensions. Correlation found between the interference levels and the activation volumes in left inferior parietal lobule (LIP) suggest that left LIP plays an important role in interference processing.

13:32  1142. Temporal Lobe Activation in Picture-Naming - Applications to fMRI Assessment in Epilepsy
Bruce Bolster\textsuperscript{1}, Ryan D'Arcy\textsuperscript{2}, Andrea Loewen\textsuperscript{1}, Lawrence Ryner\textsuperscript{3}
\textsuperscript{1}University of Winnipeg, Winnipeg, Manitoba, Canada; \textsuperscript{2}National Research Council Canada, Halifax, Nova Scotia, Canada; \textsuperscript{3}National Research Council Canada, Winnipeg, Manitoba, Canada

fMRI can provide an assessment method for evaluating outcome in different surgical treatments for temporal lobe epilepsy to determine whether or not a more restricted resection offers advantages in terms of functional outcome. We have developed a neuropsychological task that is capable of eliciting functional activation in the temporal lobes. We hypothesized that temporal regions could be activated in healthy controls by a picture-naming task that requires semantic judgements and that the pattern of these results would correspond with the pattern of the behavioural results.

13:33  1143. Implicit and Explicit Processing of Kanji and Kana Words and Non-Words Studied with fMRI
Thuy Ha Duy Dinh\textsuperscript{1}, Kayako Matsuo\textsuperscript{2}, Keiichiro Toma\textsuperscript{1}, Toshiharu Nakai\textsuperscript{2}, Hidenao Fukuyama\textsuperscript{2}
\textsuperscript{1}Kyoto University Graduate School of Medicine, Kyoto, Japan; \textsuperscript{2}National Institute of Advanced Industri, Ikeda, Osaka, Japan; \textsuperscript{3}Institute of Biomedical Research and Innovation, Kobe, Japan

Implicit language processing of kanji and kana scripts was investigated using fMRI. Size judgments for character stimuli, not scrambled-characters, and semantic decision activated Broca’s area, the left posterior inferior temporal cortex, and the left SMG. Kanji produced greater activation in the bilateral fusiform gyri. The left SMG was more activated during size judgment for kana, while Broca’s area and Wernicke’s area were more activated during kana semantic decision. These findings implied that processing of kanji and kana scripts is obligatory to Japanese subjects, and there are still script-dependent differences in explicit as well as implicit reading of kanji and kana.

13:34  1144. The Neural Basis of Sentence Comprehension of Two Languages in Korean-English Late Bilinguals
Seung-Bok Lee\textsuperscript{1}, So-Jung Yoon\textsuperscript{1}, Kwan-Jin Jung\textsuperscript{1}, Eunkyung Yeon\textsuperscript{1}, HyoWoon Yoon\textsuperscript{1}, Hyun-Wook Park\textsuperscript{1}
\textsuperscript{1}Chungbuk University, Chungju, Chungbuk, Republic of Korea; \textsuperscript{2}KAIST, Daejeon, Republic of Korea

Fourteen Korean-English bilingual subjects were volunteered in our study with using functional MRI for investigating neural mechanisms underlying processing of these two different languages. The comparison of the activated cortical areas was carried out during the semantic judgment of visually presented sentences in L1 (Korean) and L2 (English). The results indicate that the temporal region was more involved in L1 processing, whereas the more frontal region activity was to see in L2 processing.

13:35  1145. Neural Mechanism of Reading Chinese Characters and Pictures by Korean Native Speakers
Hyo Woon Yoon\textsuperscript{1}, Kyung Hwan Kim\textsuperscript{1}, Sung Ki Lee\textsuperscript{1}, Myung Sung Song\textsuperscript{1}, Jun Young Chung\textsuperscript{1}, Hyun Wook Park\textsuperscript{1}
\textsuperscript{1}KAIST, Daejeon, Republic of Korea

Functional magnetic resonance imaging technique was used for the investigation of neural mechanisms in perception of Chinese characters and pictures by Korean native speakers. Interestingly, the activation of the left middle frontal area (BA 9) was observed during the perception of pictures, but not during that of the Chinese characters. The activation of left middle frontal area was reported typically for the perception of Chinese characters by other studies with native Chinese speakers. We suggest that the neural mechanisms for reading Chinese characters by Korean people would be quite different from that by the native Chinese speakers.
13:36  **1146.** Neural Bases and Hemispheric Lateralization for Phonological Processing in Regular Languages: An fMRI Study on Italian Adults
Laura Biagi¹, Chiara Pecini¹, Domenico Montanaro², Daniela Brizzolara¹, Paola Cipriani¹, Michela Tosetti¹
¹Stella Maris Scientific Institute, Pisa, Italy; ²Institute of Clinical Physiology, Pisa, Italy

Literature suggests that further studies on normal readers must be conducted in order to define whether there are differences in the neural bases of phonological processing depending on the orthographic regularity of the language, the type of the phonological task, the stimuli used and the short term memory load required by the task. By comparing different phonological tasks in normal Italian adults, we found that the Italian reader uses preferentially the anterior components of the neural phonological network and to a less extent the posterior temporal areas. However stimuli with different characteristics (type, duration, orthography) activate the same neural circuit.

13:37  **1147.** Cooperation of Bilateral Inferior Frontal Cortices in Accent Judgment as Revealed by Functional Magnetic Resonance Imaging
Kayako Matsuo¹, Yuko Ohgami¹, Keiichiro Toma², Ken’ichi Oishi³, Chika Sumiyoshi⁴, Toshiharu Nakai¹
¹National Institute of Advanced Industrial Science and Technology, Ikeda, Osaka, Japan; ²Institute of Biomedical Research and Innovation, Kobe, Hyogo, Japan; ³Kobe University, Kobe, Hyogo, Japan; ⁴Fukushima University, Fukushima, Japan

Brain activation during accent judgment was investigated using fMRI in a 3T magnet. Ten healthy Japanese-speaking volunteers judged accent patterns of Japanese words. In Japanese, high and low pitch accent patterns determine lexical meaning of words. The left inferior frontal cortex (IFC, Broca’s area) was activated during all tasks employed, indicating lexical processing of language. The right IFC was specifically activated during the accent judgment. This might be related to a pitch processing and/or the prosody of speech. We successfully demonstrated bilateral involvement of IFC in accent judgment of Japanese, one of pitch-accent languages.

**fMRI Applications: Cognitive Function**

Room H  Monday 14:00 - 16:00

14:00  **1148.** Is Dysplastic Cortex Functional?
Regula Sofia Briellmann¹, Graeme D. Jackson¹, Anthony B. Waite¹, John S. Archer², Angelo Labate¹, David F. Abbott¹
¹Brain Research Institute, Heidelberg West, Victoria, Australia; ²James Cook University, Cairns, Queensland, Australia

Dysplastic tissue has epileptogenic properties, and may support physiological function. At 3T we assessed 25 patients with malformations with fMRI language, seven of these had frequent interictal EEG discharges and had fMRI/EEG. Analysis was performed in SPM99. Left-lateralised language activation was preserved in 22 of the 25 subjects. Only patients with DNET or TS did not activate dysplastic tissue, whereas the other MCD generally showed language-associated activation. Discharge related BOLD signal change was found in dysplastic cortex, and did not overlap with language activation. Dysplastic tissue can be involved in complex physiological functions, but also generate seizure discharges.

14:01  **1149.** An Event-related fMRI Study of Representational Momentum
Heng Yi Rao¹, Shi Hui Han¹, Yi Jiang¹, Ding Guang Gao¹, Yu Long Ding¹, Hua Gu³
¹Sun Yat-Sen University, Guangzhou, People's Republic of China; ²Peking University, Beijing, People's Republic of China; ³Beijing Chaoyang Hospital, Beijing, People's Republic of China

Representational momentum (RM) refers to a phenomenon that an observer’s memory of the final position of a moving target is usually displaced in the direction of implied motion. Event-related fMRI was used to investigate the cortical activations underlying RM task compared to a similar NRM task. RM task induced significant activations in multi prefrontal areas but little activation in MT/V5. Such results suggest that the cortical mechanism of Representational momentum is different from implied motion perception.

14:02  **1150.** Texture Segmentation in Human Perception Revealed by fMRI
Arthur Peter Wunderlich¹, Axel Tielscher¹, Heiko Neumann¹, Gerog Grön¹
¹University Clinic Ulm, Ulm, Baden-Württemberg, Germany; ²University of Ulm, Ulm, Baden-Württemberg, Germany

Based on known anatomy and physiology of lower-level visual cortical areas we implemented a model of human texture processing suggesting that area V4 plays a central role in scene segmentation. In particular, the model predicts monotonic increasing V4 activation with increasing texture saliency. This prediction was tested using fMRI scanning healthy volunteers while presenting patterns of lines with different orientatin contrast. Our modeling and imaging results indicate that V4 forms a key stage for texture border detection by gradually signaling the salience of texture discontinuities. This demonstrates how both approaches can successfully interact in elucidating higher visual functions.
Many studies suggest that people remember faces of their own race better than faces of other races (called same-race memory superiority). In our study, subjects performed two tasks on race-judgment and familiar-judgment during event-related fMRI. In the implicit task, they consciously made familiar-judgments (regardless of race); in the explicit task, they consciously made race-judgments (regardless of familiarity). In the explicit task the same-race memory superiority was observed from face fusiform areas. In the explicit task such memory superiority was observed from left middle temporal lobe.

Selective activations by a novel class of synthetic face stimuli with radial frequency were measured in human ventral V4v and FFA to examine the feature of the intermediate visual processing stage for face recognition. Two fMRI studies showed that the synthetic faces capture a significant portion of the geometric information that individuates faces and that the radial frequency information contained in the synthetic face is important at the intermediate form vision level. We also found that there is a hysteresis in face categorization. The present results clearly showed the neural characteristics of the dynamics in face categorization.

We studied the activation patterns of the visual association cortex and hippocampus during the encoding and retrieval periods using fMRI with a face-name stimulation paradigm. Both encoding and retrieval induced significant activation in the middle portion of the hippocampus and inferior visual association cortices. When directly compared, encoding showed stronger activation bilaterally in the region of anterior hippocampus, while retrieval showed stronger activation in the inferior visual association cortices. Results also demonstrate the sensitivity of this paradigm in differentiating the neural components of memory encoding and retrieval processes.

Even the same affective facial expressions may have different meanings due to social or interpersonal context. Therefore, the judgmental capacity for the appropriateness of the facial affective expressions should be one of the critical factors for human social interactions. We perform this study to identify neural correlates of this capacity using fMRI technique

An fMRI was conducted to compare brain activation between object-use gestures with real objects and those with imagined objects. The neural processes for the two gestures might differ because some patients with apraxia can use objects properly but cannot pantomime the object-uses. The two gesture conditions activated similar areas including the left parietal lobe. The gestures with real objects made by the right (preferred) hand augmented the right supramarginal activation, while those made by the left hand did not. Real objects manipulated by the preferred (right) hand might support the formation of the object concepts in the supramarginal areas.

fMRI Applications: Memory and Attention

Room H       Tuesday 13:30 - 15:30

13:30     1156. An fMRI Study of Neural Activations in the Aged and Illiterates
Geng Li1, Raymond T. F. Cheung1, Tatia M. C. Li1, Edward S. Yang1
1The University of Hong Kong, Hong Kong, Hong Kong

This study used fMRI to examine the effects of aging and education on neural activations associated with verbal and nonverbal working memory tasks in healthy right-handed 36 subjects. In aged literates, verbal and nonverbal tasks produced left hemispheric and bitemporal activations, respectively. Similar patterns of brain activations were obtained in young literates during verbal and nonverbal tasks. In aged illiterates, however, both verbal and nonverbal tasks mainly engaged left hemispheric regions at locations different from those of aged literates. Our results indicate that education but not healthy aging determines the pattern of neural activations associated with the memory tasks.
A fMRI study was conducted to evaluate the influence of stimulus pacing on the activation of the mesiotemporal lobe structures during semantic processing. 21 volunteers performed a semantic classification task both in a self-paced and a fixed-paced manner. Group and single-subject analyses were computed. Only the self-paced experiment was capable of detecting consistent MTL activation. This effect could be caused because a self-paced design is more challenging to the process of interest, and because such a design automatically implies distributed sampling over peristimulus time.

**Evidence for Motor Effector Specificity in the Auditory-Motor Domain: An fMRI Investigation**

*Judy Pa1, Gregory Hickok2*

1UC Irvine, Irvine, California, USA

Area Sgt, in the posterior Sylvian region, has been identified by recent work and is thought to support auditory-motor integration. This region exhibits auditory-motor properties, activating during perception and production of speech and music. The present 4T study sought to determine whether auditory-motor responses would vary regionally, according to motor effector system. Subjects heard a melody and were asked to covertly hum or imagine playing the melody. Area Sgt responded greater to the vocal tract effector while a dorsal parietal region responded greater to the manual effector. We suggest that auditory-motor integration systems may be organized around motor effector systems.

**Semi-Random fMRI Encoding Paradigm Shows Lateralized Anterior Mesiotemporal Lobe Activation in TLE Patients**

*Karel Deblaere1, Walter H. Backes2, Ann Tieleman3, Pieter Vandemaele4, Kristl Vonck5, Paul Hofman6, Peter Boon7, Jan Vermeulen8, Jan Wilmink9, Albert Aldenkamp10, Paul A. Boon11, Guy Vingerhoets12, Eric Achten13*

1Ghent University Hospital, Ghent, Belgium; 2Maastricht University Hospital, Maastricht, Netherlands; 3SEIN, Heemstede, Netherlands; 4Epilepsy Centre 'Kempenhaeghe', Heeze, Netherlands

This fMRI study was carried out to validate a semi-random memory encoding paradigm, and to compare the results obtained in pre-surgical temporal lobe epilepsy (TLE) patients with the intracarotid amytal procedure (IAP). Eight healthy volunteers and 12 presurgical TLE patients were included. The memory paradigm consistently activated the posterior and anterior mTL structures in both healthy volunteers and patients. Regression analysis revealed that the fMRI activation was stronger lateralised to the contralateral hemisphere than the IAP results. Further analysis showed that the LI of the right, but not the left, TLE patients showed a significant relation with the IAP.

**Effective Connectivity Changes During Visual and Auditory Selective Attention Tasks**

*Baxter P. Rogers1, Chad H. Moritz2, M. Elizabeth Meyerand2*

1University of Wisconsin-Madison, Madison, Wisconsin, USA

The temporoparietal junction, lateral frontal areas, the anterior cingulate, and the superior parietal lobe all may play a role in determining what to attend to in the presence of multiple conflicting stimuli. We used functional MRI to scan subjects while they responded to visual stimuli and ignored confounding auditory input, or vice versa. BOLD response was observed in sensory regions, areas implicated in attention, and motor regions; measurements of effective connectivity between the primary sensory areas and parietal areas suggested a parietal role in selecting which stimuli to attend to.

**fMRI of MDMA Users and Control Subjects During Delayed Memory Task**

*Joel L. Steinberg1, Frederick G. Moller2, Ponnada A. Narayana3, Donald M. Dougherty4, Khader M. Hasan1, Larry A. Kramer1, Perry F. Renshaw2*

1University of Texas-Houston Health Science Center, Houston, Texas, USA; 2McLean Hospital, Harvard University, Belmont, Massachusetts, USA

15 MDMA ("ecstasy") using subjects and 19 non-drug using controls underwent BOLD fMRI while performing a working memory task (IMT/DMT). The study was a block design in which the Delayed Memory Task (DMT) alternated with the Immediate Memory Task (IMT), which served as a control condition. Random effects SPM99 analysis showed a significant increase (whole volume corrected cluster p < 0.05) in activation on fMRI in the MDMA subjects compared to the control subjects in the medial superior frontal gyrus, the pulvinar in the thalamus extending into putamen, and in the hippocampus.
fMRI: Cocaine, Heroin, and Amphetamine

Room H  Monday 14:00 - 16:00

14:00  1163. Methoxamine Titration Induced BOLD Signals in Rat Brain: Implication on Pharmacological MRI Signal Induced by Cocaine

Feng Luo1, Marie L. Schulte1, Shi-Jiang Li1
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Peripheral mean arterial blood pressure (MABP) increase as a potential confounding factor to cocaine-induced CNS BOLD signal was investigated using methoxamine (MX). MX is a α-receptor agonist without cerebral vascular effects. MX can mimic cocaine-induced peripheral MABP perturbation profile, but produced much less BOLD signal in the rat brain. A separate bench study found that CBF remained stable in spite of MX-induced MABP perturbation. It is suggested that cerebral autoregulation filters out the psychoactive drug-induced peripheral vascular effects. The application of fMRI techniques to mapping neuronal activation induced by cocaine administration is valid when a proper dose was adjusted.

14:01  1164. Reduced Prefrontal Cortical Activation Following Repeated Cocaine Exposure: A BOLD fMRI Study in Awake Rats

Marcelo Febo1, Jeffrey R. Tenney1, Mathew Brevard1, Timothy Q. Doung1, Craig F. Ferris1
1UMASS Medical School, Worcester, Massachusetts, USA

One ‘high-end’ application of functional MRI in conscious rats is the study of the neural adaptations to repeated drug exposure. In the present study we use the blood-oxygen-level-dependent (BOLD) technique to assess the neural response to cocaine in naïve and cocaine pre-exposed rats. In order to determine if repeated exposure to cocaine affects cerebrovascular reactivity, a 5 % CO2 challenge was performed pre- and post-cocaine administration. The resulting data indicate that cocaine pre-exposed rats show a significant reduction in BOLD signal intensity in response to cocaine when compared to drug naive controls. Hypercapnia-induced BOLD contrast was not affected.

14:02  1165. Repeated Acute Cocaine Challenges Modulate the Spatial Pattern of rCBV Response to Cocaine in the Rat

Torsten Reese1, Adam J. Schwarz2, Alessandro Gozzi1, Simone Bertani1, Valerio Crestan2, Christian A. Heidbreder3, Angelo Bifone1
1GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; 2GlaxoSmithKline, Verona, Italy

This study demonstrates that two repeated cocaine challenges induce significantly different spatial patterns of brain activity in the rat as assessed by functional magnetic resonance imaging (fMRI). The response upon a second challenge of cocaine is attenuated in regions including the medial prefrontal, infralimbic, cingulate, retrosplenial and temporal cortices when compared to a previous acute cocaine challenge. These fast neuroadaptive “carry-over” effects from a previous challenge would represent a confounding factor in agonist-antagonist studies with repeated cocaine administration. This effect should be taken into account for the design of future fMRI studies in man and animal.

14:03  1166. Neural Correlates of the Reinstatement of Heroin-Seeking Behavior in Rats by fMRI

Feng Luo1, Zheng-Xiong Xi1, Gaohong Wu1, Chuang Liu3, Shi-Jiang Li1
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA; 2NIDA, Baltimore, Maryland, USA; 3Penn State College of Medicine, Hershey, Pennsylvania, USA

A self-administration (SA) reinstatement rodent model was established to investigate the long-term neuroadapation in the rat brain and its behavioral expression. After regular SA was achieved, a reinstatement behavioral test or an fMRI experiment was conducted. The rats with heroin-SA history displayed robust drug-seeking behavior triggered by either contextual cues or a priming injection, whereas saline control rats did not show such a behavioral response. fMRI results showed that both positive and negative BOLD signals were significantly more attenuated in the heroin-SA group. A possible role of opiate tolerance in mediating drug craving and relapse is suggested.

14:04  1167. Origin of Heroin Induced Negative BOLD in the Rat Nucleus Accumbens: Oxygen Metabolism Assessment

Feng Luo1, Gaohong Wu1, Heng Liu3, Shi-Jiang Li1
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Cerebral metabolic rate of oxygen utilization (CMRO2) was calculated using the transient-biophysical model to interpret heroin-induced negative BOLD in rat nucleus accumbens (Nac). Nac in which GABAergic cells dominate was chosen as the study template due to its known homogenous anatomical structure. A decreased CMRO2 and CBV were found co-localized with negative BOLD, suggesting that i-receptor mediated direct inhibition on GABAergic interneurons is the cause of heroin-induced negative BOLD in Nac.
14:05  **1168. Direct Observation of Heroin-Induced Cerebral Blood Flow Change in Rats**  
Rongyan Zhang, Feng Luo, Andzej Jesmanowicz, Shi-Jiang Li  
¹Medical College of Wisconsin, Milwaukee, Wisconsin, USA

A two-coil arterial spin labeling technique was implemented on a 3 Tesla MRI system. Direct CBF measurements were validated using hypercapnea and forepaw-stimulation paradigms. Using this technique, cerebral blood flow changes induced by heroin were studied in a rat model. Reduction of blood flow was directly observed in four different ROIs after heroin injection. This is consistent with BOLD and CBV findings, without being confined by different baseline conditions. The implementation of this technique at 3 T is significant for translational research from animal models to human studies, as most high-field human fMRI studies are performed at this field strength.

14:06  **1169. Mapping Functional Changes in Rat Brain in Response to Altered Serotonergic Function using BOLD fMRI**  
Carolyn A. Steward, Malcolm JW Prior, Victoria Chapman, Peter G. Morris, Charles A. Marsden  
¹University of Nottingham, University Park, Nottingham, Nottinghamshire, UK; ²Queen's Medical Centre, University of Nottingham, Nottingham, Nottinghamshire, UK

The combination of Selective Serotonin Re-uptake Inhibitor antidepressant drugs (SSRIs) with 5-HT2C receptor antagonists may hasten the therapeutic onset of SSRIs. The effects of these drugs on the BOLD fMRI response were investigated in rat brain. Acute systemic citalopram (SSRI) produced no significant response, SB242084 (5-HT2C receptor antagonist) produced BOLD responses in 5-HT-innervated areas, e.g. striatum, hippocampus, and co-administration of citalopram and SB242084 produced less effect than SB242084 alone. Therefore, citalopram, whilst producing no detectable BOLD responses alone, diminished responses to 5-HT2C receptor antagonism. Functional changes in the rat brain serotonergic system can be detected by BOLD fMRI in vivo.

14:07  **1170. Highly-Selective Dopamine D3 Receptor Antagonist Potentiates phMRI Response to Acute Amphetamine Challenge in the Rat Brain**  
Adam J. Schwarz, Alessandro Gozzi, Torsten Reese, Simone Bertani, Valerio Crestan, Jim J. Hagan, Christian A. Heidbreder, Angelo Bifone  
¹GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; ²GlaxoSmithKline, Verona, Italy

Dopamine receptors are of interest for new treatments of neuropsychiatric disorders such as schizophrenia and drug dependence. We examined the modulation of the Cerebral Blood Volume component of the haemodynamic response to i.v. amphetamine challenge in the rat by acute pre-treatment with the highly selective dopamine D3 antagonist SB-277011-A. Surprisingly, the amphetamine response was potentiated. This occurred in a regionally specific manner, but extended beyond the distribution of the highest concentrations of the D3 receptor. An increased dopaminergic response following D3 blockade is consistent with this receptor mediating an inhibitory action on extracellular dopamine concentration.

14:08  **1171. Functional Magnetic Resonance Imaging Detects Spatio-Temporal Differences between Drug-Naive and Amphetamine-Sensitised Rats**  
Torsten Reese, Adam J. Schwarz, Alessandro Gozzi, Simone Bertani, Valerio Crestan, Christian A. Heidbreder, Angelo Bifone  
¹GlaxoSmithKline Psychiatry Centre of Excellence for Drug Discovery, Verona, Italy; ²GlaxoSmithKline, Verona, Italy

Repeated exposure to psychostimulants such as cocaine and amphetamine is known to produce behavioural sensitisation, a long lasting effect expressed as an augmented motor-stimulant response. However the functional changes underlying to the development of this phenomenon remain elusive. We have investigated the neuroadaptations that accompany psychomotor sensitisation induced by chronic exposure to amphetamine by using functional magnetic resonance imaging following an acute amphetamine challenge at three different doses. The cortical region displayed the most significant spatio-temporal differences between the two groups.

**MR Angiography of the Brain: Techniques and Applications**

Swan  Tuesday 13:30 - 15:30

13:30  **1172. Vessel Visualization Enhancement in Parallel Imaging 3D-TOF MRA Utilizing Surface Array Sensitivity**  
Yoshio Machida, Shinici Uchizono, Nobuyasu Ichinose  
¹Toshiba Medical Systems, Otawara, Tochigi, Japan

Array coils have an important role for improving SNR and realizing parallel imaging, however, one of disadvantages of array coils is non-uniformity of sensitivity. We propose a simple algorithm to enhance blood vessel visualization in 3D-TOF-MRA utilizing this surface array sensitivity, and applied it to normal volunteer's MRA data. We have verified that peripheral vessel visualization capability is remarkably improved.
13:31  **1173. Improved Vessel Visualization in MIP/MinIP of MRA Images**  
*Prashanthi Vemuri*, Eugene G. Kholmovski, Dennis L. Parker  
1University of Utah, Salt Lake City, Utah, USA

Maximum intensity projection (MIP) and minimum intensity projection (MinIP) are the standard techniques used for the display of three dimensional (3D) MRA data sets. These display algorithms work very well when the contrast-to-noise ratio (CNR) between the vessels and surrounding tissues is high. But the MIP/MinIP angiograms of high-resolution MRA datasets can lose some vessel details due to lower CNR. In this study, a technique to create MIP/MinIP angiograms with pre-defined vessel voxel projection probability has been developed.

13:32  **1174. Non-Enhanced Dynamic Digital Subtraction MRA in Cerebral Arterio-Venous Malformations**  
*Marco Essig*, Michael Bock  
1German Cancer Research Center, Heidelberg, Germany

DMRA is better suited that TOF-MRA to assess the AVM angioarchitecture. Additionally, the method allows to assess the hemodynamics of AVMs non-invasively. First clinical results have shown that the hemodynamic information, e.g. the AVM shunt-time, helps in the risk estimation for cerebral bleeding. Patients with a short AVM shunt time tend to bleed independent of the size of the malformation. Due to the lack of vessel overlap, the AVM nidus can be clearly defined and used as the treatment target volume for radiosurgery.

13:33  **1175. Comparing the Limits of Contrast Enhanced MRA at 1.5 and 3T**  
*Osama Al-Kwifi*, Richard I. Farb, Jeff A. Stainsby, Graham A. Wright  
1Sunnybrook & Women's College Health Sciences Centre, Toronto, Ontario, Canada; 2Toronto Western Hospital, University of Toronto, Toronto, Ontario, Canada

Signal-to-noise ratio (SNR) behavior at 1.5 and 3T using different spatial resolutions is investigated with 3D contrast-enhanced MRA to determine the limitation of both field strengths in producing sufficient diagnostic SNR of intracranial arteries. The role of an 8-channel coil with and without parallel imaging in improving the limited SNR at high spatial resolution at 1.5T is then evaluated. In conclusion, a 0.5-mm isotropic spatial resolution is feasible at 3T, as a result of higher SNR. Multi-channel coils along with parallel imaging techniques are limited in improving SNR values at high spatial resolution in 1.5T for intracranial vessels.

13:34  **1176. Contrast-Enhanced MR Angiography of the Circle of Willis at 3.0 Tesla**  
*Richard McCarthy*, Timothy John Carroll, Stephen F. Futterer, James Carr  
1Northwestern University, Chicago, Illinois, USA

We have compared contrast enhanced MR angiograms acquired at 3.0 T and 1.5 T. A series of subjects were scanned using an identical imaging protocol using 1.5 T and 3.0 T. Signal to noise ratio’s were compared and vessel conspicuity was graded on a four-point scale. We found the SNR for the 3.0T image scaled with field strength. Vessel conspicuity in the sylvian fissure, carotid siphon and distal branches of the middle cerebral artery were improved at 3.0T.

*Sanjoy Nagaraja*, David Capener, Stuart Coley, Jim M. Wild, Kuan J. Lee, Iain D. Wilkinson  
1University of Sheffield, Sheffield, UK; 2Royal Hallamshire Hospital, Sheffield, UK

Arteriovenous malformations (AVM) of the brain have been increasingly recognised as an important cause of death and long-term morbidity. They are lesions that are defined by the presence of arteriovenous shunting through a nidus of coiled and tortuous vascular connections, linked by one or more fistulas, which connect feeding arteries to draining veins. AVM are treated using Stereotactic Radiosurgery, in which measurement of nidus volume is crucial. We compare CE-Slinky, a non-invasive MR technique, in the measurement of nidus volume of AVM against the gold-standard but invasive Conventional Catheter Angiography (CCA).

13:36  **1178. Differences in MR-Based Predictions of Steady and Pulsatile Flow Phenomena in Aneurysms**  
*Paul E. Summers*, Iordannis Chatziprodromou, Yiannis Ventikos, Anton Valavanis, Spyros S. Kollias  
1University Hospital Zurich, Zurich, Switzerland; 2Swiss Federal Institute of Technology (ETHZ), Zurich, Switzerland

We have used time-of-flight MRA to generate accurate intracranial aneurysmal geometries on which to base simulations of realistic, offset-sinusoidal and steady flows. Phase contrast velocity mapping provided realistic time-resolved inlet conditions. Data from 6 patients show average flow topologies from steady flow models match the realistic waveform results better than those from the offset-sinusoid. Temporal changes, not seen with steady flow models, were greatly exaggerated with the offset-sinusoid, especially for features like vorticity and shear stress. Only coarse characterization of aneurysm hemodynamics is possible using steady flow approximations. Realistic flow information is essential to accurate prediction of time-varying quantities.

Jiani Hu1, Jaladhar Neelavalli1, Csaba Juhasz1, Otto Muzik2, Karen Tong1, Steve Ashwal3, Yimin Shen1, Yang Xuan1, Zahid Latif1, Vivek Sehgal2, Diane Chugani2, Harry Chugani2, Mark E. Haacke1

1Wayne State University, Detroit, Michigan, USA; 2Children's Hospital of Michigan, Detroit, Michigan, USA; 3Loma Linda University, Loma Linda, California, USA

We report the application of susceptibility weighted imaging (SWI) in 6 patients (3 children) with Sturge-Weber Syndrome (SWS). Unlike the contrast-enhanced T1 images, this new 3D high resolution susceptibility weighted imaging illustrates explicit details of the specific location, the configuration and the extent of the leptomeningeal microvenular dysplasia. The characteristic bizarre course of deep collateral venous drainage and enlarged deep white matter veins can also be clearly seen. Conclusion: Based on the results, SWI may be an important tool in studying the pathophysiology and progressive cerebral atrophy in SWS.

13:38  **1180. Simultaneous Demonstration of Brain Surface and Cortical Veins: Comparison of Direct Reconstruction and Combination of 3D Non-Contrast Data and Subtraction MR Venography**

Makoto Amanuma1, Naoko Nishi1, Masayuki Ytasa1, Junji Tanaka1, Atsuko Heshiki1

1Saitama Medical School, Iruma, Saitama, Japan

For simultaneous demonstration of brain surface structures and cortical veins using a volume rendering technique two different methods were evaluated in 10 patients with brain tumors. The first one was direct reconstruction of postcontrast 3D data that contains high signal vascular structures. The second method is combination of non-contrast 3D surface image and reconstructed subtracted venous images. The latter one required shorter processing time and semi-automated procedures providing high-quality 3D brain surface images with cortical venous mapping. Detection of gyri and sulci was significantly easier and accurate assessment of venous structures was possible.

**Diffusion Acquisition Techniques**

Swan  Monday 14:00 - 16:00

14:00  **1181. Evaluation of the Effects of K-Space Under-Sampling in PROPELLER Imaging.**

Konstantinos Arfanakis1, Ashish Anil Tamhane1, Mark Anthony Anastasio1

1Illinois Institute of Technology, Chicago, Illinois, USA

PROPELLER acquisitions were recently introduced for use in diffusion tensor imaging. In this work, we evaluated the effects of under-sampling on the raw PROPELLER images. Under-sampling by means of altering the k-space sampling pattern to include fewer samples per line, fewer lines per blade, or fewer blades per acquisition, reduces imaging time, but introduces intensity DC shifts, and image artifacts. In contrast, under-sampling by means of discarding whole blades from a PROPELLER sampling pattern that sufficiently samples k-space, may reduce acquisition time significantly, with minimal image artifacts, mainly manifested as smoothing in directions perpendicular to the blades removed.

14:01  **1182. Diffusion Weighted Imaging Near the Base of the Brain: Reducing Magnetic Susceptibility Effects using Parallel Imaging EPI vs. PROPELLER FSE**

Tim Roberts1, Fang Liu1, Marshall Sussman1

1University of Toronto, Toronto, Ontario, Canada

In areas of high magnetic susceptibility differences, e.g. base of the brain, echo-planar based DWI methods are hampered by distortions and signal loss. Parallel imaging can reduce TE. An alternative is multishot fast-spin-echo (e.g. PROPELLER). We compared both approaches, evaluating distortions and signal-to-noise ratios. Using higher receiver bandwidth and parallel imaging with an 8-element coil reduced TE to 59ms, improving image quality. PROPELLER gave almost no evidence of anatomic distortion but needed longer scan times. For clinical application, parallel imaging is favored for uncooperative patients, and minimizing T2-shine through; PROPELLER is favored for definition of structures in inhomogeneous magnetic fields.

14:02  **1183. Accelerating MR Diffusion Tensor Imaging Via Reduced Encoding Projection Reconstruction**

Yi Jiang1, Edward W. Hsu1

1Duke University, Durham, North Carolina, USA

Practical applications of diffusion tensor imaging (DTI) are hampered by the low SNR and spatial and temporal resolutions. Due to its intrinsic oversampling of central k-space and isotropic trajectories, projection reconstruction imaging may be more suited for accelerating DTI via k-space sharing methods. Filtered reduced encoding projection reconstruction (FREPR) is implemented with the key features including the use of radial mask filters to select for spatial frequency information and constrained reconstruction in the form of phase and magnitude baseline correction. Results in simulation and experiment indicate FREPR provides a significant improvement in the acquisition-time efficiency against rectilinear k-space sharing method.
14:03  1184. Very High-Resolution Single Shot Diffusion Weighted Imaging using Parallel Imaging and Fast Receivers  
Timothy P. L. Roberts1, Marshall S. Sussman1, Anne Keller1  
1University of Toronto, Toronto, Ontario, Canada

Diffusion weighted imaging is of increasing clinical importance. Typical imaging protocols use a low resolution echo planar imaging approach with concomitant poor spatial resolution. Using parallel imaging (ASSET) and high receiver bandwidth (250kHz) we are able to acquire 256x256 matrix single shot diffusion weighted echo-planar images with high spatial resolution (<1mm in-plane) without excessive k-space blurring or TE prolongation. These are compared against typical lower resolution echo-planar diffusion weighted images in 10 healthy volunteers and 12 neurological patients with a variety of lesions, including micro-embolic strokes. Similar high resolution protocols can form the basis of diffusion tensor imaging approaches.

14:04  1185. Diffusion Tensor Imaging Without Geometric Distortions using Diffusion-Weighted Single-Shot STEAM with Partial Fourier Acquisition  
Susanne Rieseberg1, Jens Frahm1  
1Biomedizinische NMR Forschungs GmbH, Goettingen, Germany

Diffusion-weighted single-shot STEAM sequences (TSTEAM) offer an alternative solution for diffusion tensor imaging without geometric distortions. This advantage becomes even more important at higher magnetic fields. Here we combined TSTEAM with 5/8 partial Fourier phase encoding. Image reconstruction by projection onto convex subsets resulted in slightly better image quality as obtained for full Fourier phase encoding but in reduced measuring time. By investing the gain of time in an increased number of diffusion gradients, the new method yields high-quality maps of mean diffusion directions of the human brain within acceptable measuring time.

14:05  1186. A STEAM-EPI Sequence for High Resolution Diffusion-Weighted Imaging at High Field  
Karim Shmueli1, David Lee Thomas2, Roger John Ordidge1  
1University College London, London, London, UK

Preliminary experiments on an n-dodecane phantom at 4.7T show that DW-STEAM-EPI gives accurate multislice diffusion coefficients compared with literature and standard DW-SE values, despite an exponential slice-to-slice signal variation. The DW gradients only have to be applied once for a whole set of slices within a selected cuboid thereby reducing gradient ‘on’ time compared with other ‘single-shot’ DW techniques. The smaller FOV may allow a decreased echo-train length giving reduced susceptibility artifacts. The technique could be used to focus in on specific brain regions in which the higher resolution could allow clarification of fibre crossings in DTI.

14:06  1187. Optimization of Diffusion Spectrum Magnetic Resonance Imaging for Clinical Scanner  
Jun-Cheng Weng1, Van J. Wedeen1, Jyh-Horng Chen1, Timothy G. Reese1, Li-Wei Kuo1  
1National Taiwan University, Taipei, Taiwan; 2MGH Martinos Center for Biomedical Imaging, Harvard Medical School, Charlestown, Massachusetts, USA

DSI has been proposed to define tract orientations of neural fibers. The technique typically requires large gradient pulses that are not attainable in clinical scanners. By using longer and weaker gradient pulses in the clinical scanner, DSI images would be subject to truncation artifacts and produce unstable results. The goal of this study is to determine the optimum parameters of DSI in clinical scanners. Using the optimum parameters in an EPI sequence, we obtained the whole human brain scan in 20 minutes. Our results showed that DSI performed in the clinical scanners produced reasonable tract orientations in white matter regions.

14:07  1188. Spherical Encoding Method in Clinical Machine  
Hsu-Lei Lee1, Ching-Po Lin1, Wen-Yih Isaac Tseng2, Li-Wei Kuo1, Jun-Cheng Weng1, Van J. Wedeen1, Timothy G. Reese1, Jyh-Horng Chen1  
1National Taiwan University, Taipei, Taiwan; 2National Taiwan University College of Medicine, Taipei, Taiwan; 3MGH Martinos Center for Biomedical Imaging, Harvard Medical School, Charlestown, Massachusetts, USA

High angular resolution diffusion imaging (HARDI) methods maps the distribution of fiber orientations by mapping its orientation distribution function from q-space data on an icosahedral sphere. In this study we applied the spherical encoding method to human brain to examine its capability in in-vivo applications. DSI with optimized cutoff b-value was served as a standard in comparison with spherical encoding images. With half images acquisition time in contrast to DSI, spherical encoding images in 3000 mTm-1 shows an error of -0.15 ±17.5° in the coherent white matter area and -0.66 ± 22.6° in area with fiber crossing.

14:08  1189. Assessing Signal Stability in Diffusion Tensor Imaging  
Kelvin O. Lim1, Bryon A. Mueller1  
1University of Minnesota, Minneapolis, Minnesota, USA

DTI acquisition places considerable stress on scanner hardware. While signal stability has been examined in fMRI, the same has not been done for DTI. Using a DTI sequence which collects multiple slices and multiple directions every 10 secs, we characterized the signal stability for 20 minutes in a phantom. Variations in signal were observed during the DTI sequence that had not been seen in fMRI stability tests. The findings emphasize the potential of signal instability during DTI and suggest approaches for their monitoring and correction.
14:09  **1190. Effect of CSF Suppression using the FLAIR Technique on Diffusion Tensor MR Tractography**
Ming-Chung Chou¹, Yi-Ru Lin¹, Teng-Yi Huang¹, Chiao-Ying Wang¹, Hsiao-Wen Chung¹, Cheng-Yu Chen²
¹National Taiwan University, Taipei, Taiwan; ²Tri-Service General Hospital, Taipei, Taiwan

Tractograms traced from standard diffusion tensor imaging (DTI) were compared with those using FLAIR technique to suppress the signal from CSF. We demonstrated that the application of CSF suppression could increase the traced fibers near the region of ventricle and sulci.

14:10  **1191. Computation of ADC Maps from FLAIR b=0 and DWI b=1000 Reduces Contamination by Cerebral Spinal Fluid with Minimal Increase in Scan Time**
Lawrence L. Latour¹, John A. Butman², Julie Bykowski¹, Peter Basser³, Steven Warach¹
¹National Institute of Neurological Disorders and Stroke, Bethesda, Maryland, USA; ²Warren G. Magnuson Clinical Center, Bethesda, Maryland, USA; ³National Institute of Child Health and Human Development, Bethesda, Maryland, USA

Signal from partial volume averaging of cerebral spinal fluid with parenchyma in DWI results in ADC values that are artificially elevated. Suppression of CSF in FLAIR-DWI has been used to mitigate the contamination but results in excessively long acquisition times. By using DWI b=0 images in combination with a matched FLAIR image, we show that it is possible to generate “pseudo” suppressed ADC maps that have the same qualitative appeal as obtained from FLAIR-DWI, but with significantly shorter acquisition times. Results are shown for hyperacute stroke patients.

14:11  **1192. Diffusion Tensor Imaging of the Lumbar Spine with SSFSE at 1.5 T and 3 T**
Julio Carballido-Gamio¹, Duan Xu¹, David Newitt¹, Eric T. Han¹, Daniel B. Vigneron¹, Sharmila Majumdar¹
¹University of California, San Francisco, San Francisco, California, USA

The purpose of this work was to determine the feasibility of DTI-SSFSE as an alternative DTI technique for the lumbar spine at 1.5 T and 3 T. The validation was performed against DTI-LSDI, a technique previously validated for use in spine diffusion imaging. The statistical analysis included the Pearson correlation coefficient and the Bland-Altman method. Results demonstrated a good quantitative agreement between DTI-SSFSE at 1.5 T with DTI-LSDI at 1.5 T and DTI-SSFSE at 3 T indicating that DTI-SSFSE could be used as a clinical sequence to obtain diffusion images of the spine within a reasonable time.

14:12  **1193. Assessment of Parallel Acquisition Techniques mSENSE and GRAPPA in Diffusion Tensor Imaging**
Yusuf A. Bhagat¹, Christian Beaulieu¹
¹University of Alberta, Edmonton, Alberta, Canada

Parallel imaging based on k-space (GRAPPA) and image space (mSENSE) reconstruction was performed for single-shot EPI based Diffusion Tensor Imaging (DTI) of the brain on 5 normal volunteers. GRAPPA and mSENSE were compared to conventional DTI by using an 8-element phased array RF head coil and evaluating higher acceleration factors (R) up to four. mSENSE R=2 and 3 and GRAPPA R=2 yielded good quality fractional anisotropy (FA) and Trace/3 ADC maps although there were some significant quantitative differences in FA and Trace/3 ADC in cortical gray matter and deep white matter relative to conventional DTI.

14:13  **1194. Diffusion Tensor Imaging Tractography Using Fluid-Attenuated Inversion Recovery**
Luis Concha¹, Donald W. Gross¹, Christian Beaulieu¹
¹University of Alberta, Edmonton, Alberta, Canada

Partial-volume averaging of cerebro-spinal fluid (CSF) causes a significant decrease in the fractional anisotropy (FA) of adjacent brain tissue voxels. Tractography algorithms depend upon FA thresholds to define tract continuation and hence decreased FA values could result in premature tract termination or omitted tracts of white matter bundles close to CSF. The role of fluid-attenuated inversion recovery (FLAIR) for DTI tractography of fiber extraction in the fornix (surrounded by CSF) was assessed in five normal volunteers. The use of FLAIR DTI resulted in a 50% increase of the number of fibers extracted in the fornix compared to conventional DTI.

14:14  **1195. New Approach for Simultaneous Measurement of ADC and T₂ from Echoes Generated via Multiple Coherence Pathways**
Henry Ong¹, Chih-Liang Chin¹, Suzanne L. Wehrli², Xiaoping Tang¹, Felix W. Wehrli¹
¹University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA; ²Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA; ³University of Nevada, Reno, Nevada, USA

The study of rotational and translational diffusion requires the measurement of both the T₂ and apparent diffusion coefficient, quantities that are typically measured in separate experiments. The exploitation of echoes generated via multiple coherence transfer pathways offers an opportunity for measuring T₂ and ADC values simultaneously in a single experiment. The performance of the method – dubbed SMART (Simultaneous Measurement of ADC and Relaxation Time) – is demonstrated with a 0.5mM GdCl₃ doped distilled H₂O phantom showing that the derived ADC and T₂ maps agreed well with those obtained with conventional PGSE and CPMG methods.
14:15 **1196. Diffusion MRI at Large b Values: What’s the Limit?**

Carlos Contreras Meca¹, Steren Chabert¹, Denis Le Bihan³

¹SHFJ/CEA, Orsay, France

It has been observed that in vivo diffusion deviates from monoexponential decay described for free medium. Although more complex models have been proposed, the signal nature remains elusive. Information encoded at high b values will allow better description of the decay and should aid to assess the model pertinence. The question is how high in b value can we go in experimental conditions and still get relevant information. Using a non-parametric Wilcoxon test, it is shown that at 1.5T, relevant signal can still be acquired at very high b (up as 18000 s/mm²), where therefore new information could be retrieved.

14:16 **1197. Limitations of Condition Number as an Optimization Metric for Diffusion Gradient Schemes**

Aziz Hatim Poonawalla¹, Xiaohong Joe Zhou²

¹UT MD Anderson Cancer Center, Houston, USA; ²Center for MR Research, Chicago, Illinois, USA

DTI gradient schemes obtained via minimization of condition number are not as rotationally invariant as the icosahedral set, suggesting limitations of its use as an optimization metric. An alternate metric, the sum of the tensor variances $\sum_\sigma$ is compared to condition number for several selected gradient schemes: icosahedral, electrostatic repulsion, and downhill-simplex minimization of condition number. The condition number was insensitive to increased number of gradients N, but $\sum_\sigma$ decreased monotonically as N increased for all schemes. The results suggest that relying on condition number alone to evaluate diffusion schemes may be insufficient when seeking to optimize DTI acquisition strategies.

14:17 **1198. Optimization of b-Factor in Diffusion Circular Spectrum Mapping for Identifying Intravoxel Fiber Crossings**

Wang Zhan¹, Elliot A. Stein¹, Yihong Yang¹

¹National Institutes of Health, Baltimore, Maryland, USA

A study is present to optimize the b-factor for the recent developed diffusion circular spectrum mapping (DCSM) technique, which is able to identify fiber crossings in the human brain. The 4th-order DCSM maps were calculated on a digital phantom with different b-factors at various SNR levels. The contrast-to-noise ratio (CNR) between fiber-crossing area and planar area was used to specify the effectiveness of the 4th-order map. Results indicated that a higher SNR leads to a higher CNR of the 4th-order map. For a fixed SNR, the maximum CNR can be obtained when an optimized b-factor (2000-2500 s/mm²) is applied.

14:18 **1199. Comparison of Methods for High Angular Resolution Diffusion Imaging**

Adam W. Anderson¹, Zhaohua Ding²

¹Vanderbilt University, Nashville, Tennessee, USA

Several methods exist for characterizing the orientational dependence of diffusion in tissues. Although these differ widely in their requirements for data acquisition and underlying assumptions, little work has been done to compare the available methods and identify their relative strengths and weaknesses. This work makes a direct comparison of five different approaches using in vivo human data.

14:19 **1200. Combined DTI and q-Space Analysis at High Angular Resolution of the Human Brain**

Yanit Assaf¹, Ofer Pasternak¹, Peter J. Basser⁷

¹Tel Aviv Sourasky Medical Center, Tel Aviv, Israel; ²Tel Aviv University, Tel Aviv, Israel; ³The National Institutes of Health, Bethesda, Maryland, USA

High-b-value diffusion imaging complements diffusion tensor imaging providing specific information about water mobility in highly restricted compartments such as white matter. Here we used a model that combines contributions of hindered diffusion arising from extra-axonal spaces, and restricted diffusion arising from intraaxonal space. We used high angular resolution high-b-value DWI acquired on human brain. Using the model we were able to characterize separately both the hindered and restricted components of the signal decay. The model was able to distinguish between two orientations of fibers within the same pixel which may significantly improve fiber tracking methodologies, particularly in complicated neural pathways.

14:20 **1201. Multi-Scatter Diffusion Imaging: Calibration for Isotropic Diffusion Sensitivity**

Ching-Po Lin¹, Jyh-Horng Chen², David S. Tuch²

¹National Taiwan University, Taipei, Taiwan; ²Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA

By encoding the spin position with multiple non-collinear pulsed gradients, multi-scatter diffusion imaging may be able to measure the lengthscales separating subvoxel diffusion compartments. Multi-scatter diffusion imaging may also be able to resolve composite intravoxel structure not resolvable with current high angular resolution diffusion imaging methods such as intravoxel fiber dispersion and twisting. The canonical multi-scatter sequence is not suited to measuring diffusion anisotropy, however, due to directionally-dependent interaction term between the scattering vectors. Here, we describe a series of modifications to the multi-scattering sequence to suppress the cross-talk term and achieve isotropic diffusion sensitivity.
Numerical Analysis of the Feasibility of finite-$\Delta q$-space probability measurements in human white matter
Nicolas Francisco Lori, Thomas Edward Conturo
Washington University School of Medicine, St Louis, Missouri, USA

We analyze the limitations in doing q-space imaging using finite-duration diffusion encoding gradients typical in human MRI, for the case of restricted cylinders symilar to white matter axons. Random-walk simulations indicate that, if the angle between the cylinder axis and the diffusion-encoding gradient is smaller than 50 degrees, then a finite-$\Delta q$-space analysis is able to obtain the correct displacement probability.

A Dedicated Phantom for Diffusion Tensor Imaging Studies
Paola Scifo, Flavio Dell'Acqua, Giovanna Rizzo, Maria Carla Gilardi, Ferruccio Fazio
Istituto Scientifico H San Raffaele, Milan, Italy; Università degli Studi di Milano-Bicocca, Milan, Italy

EPI-Diffusion Tensor Imaging is a relatively rapid and established method for the studies of white matter myelin fiber bundles. SENSE technique can be conveniently combined with DTI to reduce susceptibility artefacts by shortening the duration of the echo train. To optimise acquisition parameters for fiber tracking studies, the availability of a "tracking phantom" can be useful. In this work, we describe and evaluate the phantom built for optimising DTI acquisition parameters for fiber tracking studies.

Microscopic ADT Determination with Multiple Echo Manipulation to Improve Efficiency and Accuracy
Vikas Gulani, Thomas Weber, Andrew G. Webb
Universität Würzburg, Würzburg, Germany; University of Illinois, Urbana-Champaign, Illinois, USA

In high-field NMR microscopy, rapid imaging methods for determination of ADT (i.e. EPI) cannot be used due to large magnetic susceptibility effects. We propose a pulse sequence in which a diffusion-weighted spin-echo is followed by multiple gradient echoes with additional diffusion weighting, and with each echo contributing to a different image. These can be used to calculate the ADT and T2* maps. We show here that this results in improvements in both accuracy of ADT determination (due to fitting with a larger number of images) and also increased time efficiency. The method is tested on excised, fixed rat spinal cords.

Calculating and Modeling Diffusion

A Rigorous Method for Calculus on Diffusion Tensors: Taking into Account Positivity of Eigenvalues
Philip G. Batchelor, Fernando Calamante, Maher Moakher, David Atkinson, Alan Connelly, Derek L. G. Hill
Kings College, London, UK; University College London, London, UK; Ecole Nationale d'Ingenieurs de Tunis, Tunis-Belvedere, Tunisia

Common scalar measurements in Diffusion Tensor MRI (FA, means, etc.) do not explicitly use the requirement for positive eigenvalues, which we argue can lead to flawed or counter-intuitive interpretations. We propose here to use a definition of distance on the space of diffusion tensors which explicitly takes into account this positivity. We derive from that as an example a new, formally justified, anisotropy measure. Furthermore, we describe how this space of diffusion tensors allows a formal means of computing the mean of a set of diffusion tensors.

Diffusion Anisotropy With And Without The Tensor Model
James G. Pipe, Konstantinos Arfanakis
Barrow Neurological Institute, Phoenix, Arizona, USA; Illinois Institute of Technology, Chicago, Illinois, USA

This work compares a previously published non-tensor metric of diffusion anisotropy, G, with the conventional tensor-based fractional anisotropy, FA. For data that exactly fit a tensor model, G and FA are essentially identical. If the data deviate from a tensor model (e.g. from noise or from more complex diffusion), the tensor fitting smooths the data, reducing the value of FA with respect to G. Comparison of FA and G may be generally helpful in identifying the effects of tensor assumptions on FA. Additionally, G may be a preferable metric to FA in high-SNR data.

Modeling Molecular Diffusion in Brain Using Bayesian Probability Theory
Christopher D. Kroenke, G. Larry Brethorst, Alpay Ozcan, B Yoder, T E. Inder, Jeffrey J. Neil
Washington University School of Medicine, St. Louis, Missouri, USA; Southwest Foundation for Biomedical Research, San Antonio, Texas, USA; University of Melbourne, Melbourne, Victoria, Australia

In diffusion tensor imaging (DTI) the directional dependence of water diffusivity is modeled as a rank two tensor. The possibility exists that a more elaborate mathematical model would be more informative than DTI about the imaged tissue structure. Herein, Bayesian probability theory is used to analyze high signal-to-noise diffusion data from fixed whole baboon brain. A scheme for developing a parsimonious model of the data is described, and the resulting model is found to differ from the DTI analysis by the addition of a sub-population of immobile molecules. The size of this sub-population provides a new source of image contrast.
A Novel Denoising Technique for Very Noisy Diffusion Tensor Imaging Data
Klaus R. Hahn1, Sergei Prigarin2, Khader Hasan3
1GSF-National Research Center for Environment and Health, Neuherberg, Bavaria, Germany; 2Institute of Computational Mathematics & Mathematical Geophysics, Novosibirsk, Siberia, Russian Federation; 3Medical School of University, Houston, Texas, USA

Experiments with low signal-to-noise-ratios (SNR), caused e.g. by small voxels or high b-values, give key information about anisotropy or fiber organization, but, due to dominating and complicated noise impact, they are hard to analyze. Monte Carlo simulations were performed to find convenient variables and strategies for voxelwise and spatial smoothing. For minimal experiments the magnitude signals, for multigradient arrangements the main fiber directions are preferable variables. A new edge preserving filter, adapted to spatially varying, non-Gaussian noise and to geometric peculiarities of DTI is validated by a gold-standard-model and applied to very recent 1x1x1 mm³ data with mean SNR=3.

The Effect of Gaussian Noise on Generalized Diffusion Tensor Imaging
Chunlei Liu1, Roland Bammer1, Michael E. Moseley1
1Stanford University, Stanford, California, USA

Generalized diffusion tensor imaging (GDTI) was introduced to characterize non-Gaussian diffusion. It has been shown that non-Gaussian properties of a diffusion process can be characterized by a series of generalized diffusion tensors. Those higher order diffusion tensors (HOT) can be used to reconstruct the probability density function of the random displacement. In this abstract, the effect of noise on the HOTs and the PDF is investigated by using random walk simulation. Gaussian noise with two levels of standard deviation was added to the signal. The estimated HOTs and the reconstructed PDF are compared to that of the noiseless situation.

Diffusion Tensor Imaging Noise Removal for Tissue Fiber Tracking
Bin Chen1, Edward Hsu1
1Duke University, Durham, North Carolina, USA

In diffusion tensor imaging tractography, the noise level in diffusion weighted images has a direct impact on the accuracy of diffusion tensor orientation which is usually used as local fiber direction. We demonstrate that vector based diffusion filter with norm constrain has rigid theoretical background and better noise removal result on directional unit vector field regulation. A tissue property integrated framework for diffusion filter is introduced for anatomical information driven filtering. The applications in simulated data and in situ mouse brain data reveal significantly improved brain white matter fiber tracking results.

Biexponential Diffusion Fit under Rician Noise Assumption
Carlos Contreras Meca1, Steren Chabert1, Denis Le Bihan1
1SHFJ/CEA, Paris, France

It has been observed that in vivo diffusion deviates from mono-exponential decay described for free medium. Bi-compartmental models for diffusion have been proposed to explain diffusion behaviour, but the exact nature of the signal is still open and strongly debated question. For that matter, solid data is needed to confirm or infer proposed models. Due to the need of exploring high b-values to retrieve slow diffusion information, rician noise is seen to contaminate high diffusion weighted data and introduce a non negligible bias on fitted parameters. Noise cut-off and rician assumption fit are proposed and tested.

Gradient Distortion Correction for 3D Diffusion Tensor Microscopy
Nilesh N. Mistry1, Edward W. Hsu1
1Duke University, Durham, North Carolina, USA

Diffusion tensor microscopy is often plagued by distortion in the diffusion-sensitized directions due to eddy currents induced by large diffusion gradients. In this work we have corrected for this distortion using mutual information as the cost function, and applied this technique to real 3D diffusion data. We evaluated the performance of various cost functions, along with the effect of different interpolation techniques on convergence. We suggest the use of Fourier transform based transformations to overcome convergence related problems. We documented marked improvement in the Fractional Anisotropy maps following distortion correction, supporting its use in 3D diffusion tensor imaging.

Nonlinear Registration of Diffusion Tensor Images Using Directional Information
Gustavo Kunde Rohde1, Sinisa Pajevic1, Carlo Pierpaoli1
1National Institutes of Health, Bethesda, Maryland, USA

The problem of registering Diffusion Tensor (DT) images is considered. We describe a novel intensity based registration method capable of dealing with multi-channel images such as DT images. We use this method to register 3D DT images of the human brain based on several channel configurations derived from the DT model. Experiments performed with real and simulated data show that the use of the directional information present in the DT elements can, in many instances, significantly improve the accuracy of the registration when compared to methods that use rotationally invariant scalar information.
Adaptive control grid interpolation (ACGI) follows structure in a 3D fashion, giving better accuracy and avoiding blurring compared with conventional interpolation techniques, and may be applicable to DTI data. To demonstrate this utility, ACGI was applied to DTI images acquired with 100% skip at 3T to derive DTI data in the skipped slices. The resultant fractional anisotropy (FA) in corpus callosum was compared with experimental data obtained without the gap. The results demonstrated that ACGI is robust for interpolating DTI data.

Diffusion measurements in brain tissue adjacent to CSF-filled cavities can be severely biased due to CSF partial volume contamination. While FLAIR has been used to solve this problem, it results in reduced SNR and precludes the use of cardiac gating. We propose a novel post-acquisition method for removing the bias due to CSF contamination. By fitting a two-compartment model, where one compartment is constrained to have diffusion characteristics of CSF, we estimate the un-contaminated diffusion tensor and the relative volume fractions of the CSF and tissue components. The efficacy of this approach is demonstrated both in normal and edematous tissue.

Diffusion Tensor Imaging is a unique technique for characterizing the microstructure and the organization of biological tissues. In this study, directional color maps of the three eigenvectors of the tensor were used to investigate the relation between brain white matter structures orientation and shape and their diffusion properties. Color maps of the median and minor eigenvectors present structure or region-specific color patterns, which indicates specific diffusivity patterns in planes perpendicular to the tract direction. In structures such as corpus callosum and corona radiata, water appears to diffuse faster in the structure plane than in the direction perpendicular to it.

To study intra-voxel heterogeneity in the human brain using DWI, a stretched-exponential model of signal attenuation versus b (500-7000s/mm²) was applied. Two parameters were obtained: a heterogeneity index “alpha” and a distributed diffusion coefficient DDC. The model was fitted in to signal attenuation from three volunteers with diffusion gradients applied in three directions, and relative anisotropy (RA) was calculated for both of the parameters in gray-matter (GM) and white-matter (WM). It was discovered that the RA of alpha does not increase in WM relative to GM, while RA of DDC does. A tensor model of DDC is thus proposed.

The diffusion characteristics of slowly diffusing water populations in the human brain can be determined by employing higher levels of diffusion sensitivity than have been used previously. Here we measure the diffusion tensor at high b values (up to 3000 s mm⁻²) and demonstrate that the slow diffusion tensor exhibits enhanced diffusion anisotropy compared with the fast tensor. We also show that the slow tensor is advantageous for tractography of the white matter structures of the brain, providing longer track lengths for a given anisotropy and angular threshold.

Magnetic resonance diffusion imaging was used, for the first time, to assess quantitatively slow and intermediate diffusion rates (D1, D2) of water in brain tissue and the fast pseudo-diffusion (D3) of microvascular flow, during the first four hours post-embolic stroke in a rabbit model. D1, D2 and the corresponding fractional volumes of brain contributing to D1 and D2 (f1, f2) changed within ten minutes of onset of ischemia. D3 did not change at any time point, but the corresponding f3 decreased slowly suggesting a reduction in the number of patent microvessels, but unchanged velocity of flow in remaining patent microvessels.
A new method to estimate a mixture diffusion model is developed. Instead of attempting to find a solution in the high-dimensional space of the original problem, the present method decomposes the problem into an equivalent number of 1D problems that are much simpler to solve in practice and then composes the solution to the original problem from the solutions of the 1D problems. This technique was verified using computer simulations to assess its robustness under different conditions of SNR and voxel components.

The integrity and course of white matter fibre tracts is of key importance in understanding functional relations between different brain regions. Due to the inherent noise of MR diffusion measurements the direction and size of diffusion tensor may be inaccurate, leading to erroneous results in terms of the derived white matter fibre paths. Here we present a novel way to reduce noise in diffusion tensor images by applying Bayesian statistics to the whole diffusion tensor in the tensor field. The method is stable, converges rapidly and retains directional information even for smaller (well defined) fiber bundles.

Diffusion tensor magnetic resonance imaging (DT-MRI) allows the investigation of diffusion differences between tissues in vivo, which reflect the physiological and structural properties of tissues. However, DT-MRI measurements are sensitive to noise. Some work has been presented for regularization of DT-MRI images, either for the whole data, or only the principal diffusion direction. We presented a new regularization process for DT-MRI images that restores the whole tensor using nonlinear anisotropic diffusion scheme. Results demonstrate that tensor field regularization using nonlinear smoothing is satisfied and reproducible. These effects are particular important when DT-MRI is used for connectivity analysis of fiber tracts.

We propose a novel approach for robust estimation of the diffusion tensor. Our method enables the identification and subsequent exclusion of artifacts, such as physiological motion, from the DWI data. Results from both computer-simulated and clinical diffusion datasets indicate that our approach improves the tensor estimation when compared to non-linear least squares methods that use constant weighting, and methods that use iterative reweighting.

Probabilistic tractography methods define a probability density function (PDF) in each voxel, which describes the uncertainty in the local fibre orientation. We use an established statistical PDF, the Watson distribution, to model the uncertainty in fibre-orientation caused by signal noise. We test our model on synthetic data using the Probabilistic Index of Connectivity to generate connection probability maps. As a gold standard, we synthesise a probability map by adding noise to the simulated MR signal instead of sampling a PDF. We show the correlation of probability maps from the PDF to the gold standard, over a range of tensor anisotropy.

A method for approximating functions sampled on the sphere has been used for the analysis of human brain high-angular resolution DT MRI. Using the DW samples acquired at various gradient directions, it derived DW signal as a continuous function of the DW directions. Since the method inherently filters noise out, substituting the DW samples by the value of the function at the respective DW direction suppressed noise-induced bias at low anisotropy. The method was also combined with principal component analysis, and calculated successfully absolute scalar diffusion metrics without using quantitative diffusion models, such as those used in multivariate fitting.

Tensor tools developed for DTI are utilized to determine the direction of the texture in conventional structural images. By making an analogy of the variance along a set of templates in the structural image to the anisotropic diffusion attenuation along the diffusion-encoding gradient, the direction of the texture can be extracted using the same calculation process as in DTI. The estimated texture direction was applied to image enhancement and fiber tractography.
**Separation of White Matter Fascicles From Diffusion MRI Using \( \Phi \)-Functional Regularization**

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White matter mapping using Diffusion Tensor Imaging (DTI) has shown to give erroneous results in inhomogeneous voxels containing crossing white matter fibers. In such voxels DTI usually results with one calculated orientation, most probably different than any of the real fiber orientations. This error affects most of the fiber tracing methods by diverting the tract when it passes through inhomogeneous voxels. We propose to use a multiple diffusion tensor approach combined with \( \Phi \)-functional regularization to provide multiple orientations per voxel. We test this algorithm both on synthetic data and experimental data.

**Toward a Highly Valid Quantitative Study of Diffusion Tensor Fields**

Dongrong Xu\(^1\), Hao Huang\(^1\), Dinggang Shen\(^1\), Setsu Wakana\(^2\), Lidia Poetscher\(^2\), Christos Davatzikos\(^3\), Peter C.M. van Zijl\(^2\), Susumu Mori\(^2\)

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The statistics of the normalized diffusion tensor field is useful for quantitatively characterizing pathological changes and white-matter-structure variations. In previous studies, co-registered T1-weighted images were used to normalize DT images, in which disagreement between the DTI and the T1-weighted images caused by EPI-related image distortion may affect the validity of the normalization. In this presentation, we minimized this shortcoming by using SENSE imaging and averaged DTI maps obtained from normal volunteers. T1-DTI discrepancy map confirmed a small amount of distortion. Various white matter structures could be clearly appreciated in the average map, suggesting a possibility of quantitative study.

**Analytical Model of Water Diffusion in Rat Isocortex Slices**

Timothy M. Shepherd\(^1\), Peter E. Thelwall\(^1\), Greg J. Stanisz\(^2\), Stephen J. Blackband\(^1\)

\(^1\)University of Florida, Gainesville, Florida, USA; \(^2\)Sunnybrook/University of Toronto, North York, Ontario, Canada

The biophysical basis for water diffusion in healthy and ischemic nervous tissue remains poorly understood. Hippocampal slices offer an insightful model for exploring the origins of MR signals in tissues, but are complicated by significant heterogeneity in both tissue structure and MR signals. This study examines the utility of cortical brain slices which offer a relatively homogeneous tissue, improving the SNR and the data robustness for modelling. The results indicate that transmembrane water exchange may be significantly shorter than previously reported.

**Transverse Relaxation is Important When Modelling Water Self Diffusion in Brain Tissue**

Peter Vestergaard-Poulsen\(^1\), Troels Nørregård Laursen\(^1\), Rikke Jakobsen\(^1\), Brian Hansen\(^2\), Leif Østergaard\(^1\)

\(^1\)Aarhus University Hospital, Aarhus, Denmark; \(^2\)Aarhus University, Aarhus, Denmark

Several studies have modelled tissue diffusion to study i.e. the underlying cellular mechanisms of acute ischemia, however absolute values of ADC and cellular volume fractions have deviated from that of experiments. In contrast to former studies we have developed an analytical model, which includes T2 relaxation because several factors indicate that the ADC is influenced by differences in T2 between compartments - especially at slow exchange. By incorporating T2 relaxation in a model we predict a high ADC dependence on the echo time. The model produced realistic values of ADC, volume fractions and tortuosity when fitted to experimental data.

**Cytoarchitectural Basis for Water Diffusion in Rat Hippocampal Slices**

Timothy M. Shepherd\(^1\), Peter E. Thelwall\(^1\), Michael A. King\(^2\), Edward D. Wirth, III\(^3\), Stephen J. Blackband\(^1\)

\(^1\)University of Florida, Gainesville, Florida, USA; \(^2\)University of Chicago, Chicago, Illinois, USA

Brain slices can be used to investigate the biophysical basis for water diffusion in nervous tissue. In this study, we report water diffusion differences for unique anatomical regions of rat hippocampal slices and relate them to cytoarchitectural differences. Unlike the dynamic structure changes in ischemic tissue, viable hippocampal slices provide a relatively static model of different tissue geometries. This data provides novel insights for developing better analytical models of water diffusion in nervous tissue.
**13:33**  
**1232. Diffusion and Extracellular Space Volume in the Cerebral Cortex in a Mouse Model of Alzheimer’s Disease**  
Ivan Vorisek\(^1\), Tatiana Anto*anova\(^1\), Tomas Mazel\(^1\), Melanie Meyer-Luehmann\(^2\), Mathias Jucker\(^2\), Milan Hajek\(^3\), Eva Sykova\(^1\)  
\(^1\)Institute of Experimental Medicine ASCR, Prague, Czech Republic; \(^2\)University of Tübingen, Tübingen, Germany; \(^3\)Institute for Clinical and Experimental Medicine, Prague, Czech Republic

We studied diffusion in the brain of APP23 mice, an animal model of Alzheimer’s disease. We employed two methods: diffusion-weighted MRI and the real-time iontophoretic tetramethylammonium (TMA) method. As revealed by the TMA method, the presence of amyloid plaques in the extracellular space (ECS) was associated with increased ECS volume, more in females than in males. Changes in ECS volume corresponded to an increase in the apparent diffusion coefficient (ADC) of water. In females, there was a significant decrease in the ADC of TMA, reflecting impaired ECS diffusion. The diffusion changes can affect extrasynaptic transmission, neuron-glia interaction and disease progression.

**13:34**  
**1233. Effect of Fixative Osmolality on Biological Tissue Microstructure Studied with an Erythrocyte Ghost Model**  
Peter Edward Thelwall\(^1\), Timothy Michael Shepherd\(^1\), Greg J. Stanisz\(^2\), Stephen John Blackband\(^1\)  
\(^1\)University of Florida, Gainesville, Florida, USA; \(^2\)University of Toronto, Toronto, Ontario, Canada

MRI studies of chemically fixed samples have become common, but there is no consensus on optimal fixation methods. We studied the effects of altering the osmolarity of fixative solutions on tissue microstructure using a simple tissue model composed of erythrocyte ghosts. Our data demonstrate that the morphology of tissue microstructure present at the time of fixation is maintained, despite washing with isotonic buffer after fixation and prior to MR investigation. This illustrates the importance of consistent fixation methods and suggests that subtle microstructural changes, such as caused by brain ischemia, may be preserved for later in depth study with diffusion-MRI.

**13:35**  
**1234. Temperature Dependent Changes in the Diffusion Properties of Water in Biological Tissues**  
Peter Edward Thelwall\(^1\), Greg J. Stanisz\(^2\), Timothy Michael Shepherd\(^1\), Stephen John Blackband\(^1\)  
\(^1\)University of Florida, Gainesville, Florida, USA; \(^2\)University of Toronto, Toronto, Ontario, Canada

The diffusion properties of water in biological tissues are determined by tissue microstructure and can be used to report on microstructural change. Diffusion MR studies of ex vivo samples and model biological systems are often performed at lower temperatures than in vivo studies (room temperature vs body temperature). Water diffusion rate increases with temperature, but in biological tissues the temperature dependence of water diffusion properties is complex due to restriction and compartmental exchange effects. We investigated the relationship between temperature and the diffusion properties of water with a model biological tissue composed of erythrocyte ghosts.

**13:36**  
**1235. On the Nature of NAA Diffusion and the Apparent Viscosity Inside Neurons of the Central Nervous System**  
Christopher D. Kroenke\(^1\), Joseph J.H. Ackerman\(^1\), Dmitriy A. Yablonskiy\(^1\)  
\(^1\)Washington University School of Medicine, St. Louis, Missouri, USA

N-acetylaspartate (NAA) diffusion measurements are used to estimate the apparent viscosity of neuronal cytoplasm, in situ, in the mammalian central nervous system. The diffusion-sensitized NAA MR signal depends upon \(b\) in a non-monoexponential manner. We provide a quantitative description of this dependence using a theoretical model in which NAA is confined to multiply-oriented neuronal fibers. We find that diffusion parallel to fibers, \(ADC_{\text{par}}\), is \(0.36\pm0.06\ \mu\text{m}^2/\text{ms}\), and diffusion perpendicular to fibers, \(ADC_{\text{per}}\), is severely reduced at \((2.3\pm7.6) \times 10^{-4}\ \mu\text{m}^2/\text{ms}\). From \(ADC_{\text{par}}\), the apparent viscosity of the neuron cytoplasm is estimated to be two-fold larger than aqueous solution.

**13:37**  
**1236. Biophysical Modeling of Cortical Cell Swelling Effects in Functional Diffusion MRI Signal**  
Nicolas Francisco Lori\(^1\), Denis Le Bihan\(^2\)  
\(^1\)Washington University School of Medicine, St Louis, Missouri, USA; \(^2\)CEA, Orsay, France

We propose a simple model of the cortex to study the effects of cortical cell swelling on the functional diffusion MRI signal. Exchange and restriction effects are taken into account in our analysis.

**13:38**  
**1237. Why is the Trace of the Diffusion Tensor Constant Across Brain?**  
Ashok Kumar\(^1\), David S. Tuch\(^1\), Alma Gregory Sorensen\(^1\)  
\(^1\)Massachusetts General Hospital, Boston, Massachusetts, USA

Despite widespread observation that the trace of the diffusion tensor is constant across brain tissue, there has been no sufficient theoretical explanation for why this is the case. Here, we show that the Hashin-Shtrikman bounds (originally developed to describe the effective properties of composite materials) can explain the trace conservation in brain tissue. The HS bounds are extremely general and they do not depend upon the geometry or distribution of the individual components in the composite. We argue that these bounds are narrow for the trace of the diffusion tensor in the brain, and therefore explain the observed trace conservation.
13:39  **1238. Relevance of the Information about the Diffusion Distribution In Vivo Given by Kurtosis in q-Space Imaging**

Sureen Chabert¹, Carlos Contreras Meca¹, Denis Le Bihan¹
¹SHFJ / CEA, Orsay, France

Gaussian assumption for in vivo diffusion distribution is today questioned. Complexity of tissue structure suggests different displacement distribution behaviors. The aim here was to produce quantitative maps indicating by how much diffusion differs locally from a gaussian distribution in human brain. Qspace technique allows direct measurement of this distribution, from which excess kurtosis can be computed, and used as "index of gaussianity". Diffusion is seen to differ significantly from a gaussian process in the brain, both in gray and white matter. This index appears as a promising approach to better characterize local structural effects which might affect the diffusion process.

13:40  **1239. The Effect of Formaldehyde Fixation Over Time: DTI Parameters of Brain Tissue**

Claudia A.M. Wheeler-Kingshott¹, Klaus Schmierer², Phil A. Boulby¹, David H. Miller¹
¹Institute of Neurology, London, UK

This study investigates the effect of formaldehyde fixation on Diffusion Tensor Imaging (DTI) parameters in post mortem (PM) brain tissue. A PM brain slice of a Multiple Sclerosis (MS) patient was scanned under fresh condition and then weekly for two months following fixation. DTI parameters of normal appearing white matter as well as an MS lesion were acquired. Fractional anisotropy is stable over the study period (8 weeks), while mean diffusivity is decreased and returns to its initial value after 5 weeks.

13:41  **1240. Time Course of Transient Changes of the Apparent Self-Diffusion Coefficient during Task Activation**

Ute Goerke¹, Harald E. Möller¹
¹MPI for Cognitive Neuroscience, Leipzig, Sachsen, Germany

It was previously reported that the apparent self-diffusion coefficient decreases during stimulation. To reduce such signal variation ECG-triggering was implemented in a diffusion-weighted stimulated-echo sequence. The signal stability and therefore the statistical significance of diffusion coefficient changes was improved. Trial averages with sufficient temporal resolution showed that the diffusion coefficient change reached a plateau well before the maximum of BOLD signal change. This finding suggests that the detected changes of the diffusion coefficient take place in the extravascular compartment probing neuronal activity more directly than the vascular response.

13:42  **1241. Functional Magnetic Resonance Imaging Based on Trace Imaging**

Kimitaka Anami¹, Jun Okamoto², Nagahisa Okamoto¹, Hiroshi Matsuda¹, Osamu Saitoh¹
¹National Center Hospital for Mental, Nervous, and Muscular Disorders, NCNP, Kodaira, Tokyo, Japan; ²Siemens-Asahi Medical Technologies Ltd, Shinagawa-Ku, Tokyo, Japan

ADC (apparent diffusion coefficient) mapping with a high b value has been proposed as a novel functional imaging independent from hemodynamics. The trace - the best marker for an isotropic diffusion state can keep constant irrespective of subject’s rotating motions and requires a single scan, which allows high-speed image acquisition. Based on these advantages, we attempted to confirm whether or not trace imaging could detect neural activation using a visual task. In result, ADC change was small but significantly observed (p<0.005, uncorrected) in bilateral occipital areas during visual stimulation.

13:43  **1242. F MRS and Diffusion MRI Analysis of Cytosine Deaminase-Uracil Phosphoribosyltransferase Fusion Protein Results in Enhanced Deamination of 5-Fluorouracil and Increased Therapeutic Efficacy**

Jadranka Stojanovska¹, Daniel A. Hamstra¹, Joseph M. Tycehewicz¹, Kuei C. Lee¹, Victor D. Shepkin¹, Bradford A. Moffat¹, Mark Chen¹, Kenneth J. Dornfeld¹, Juri G. Tjuvajev¹, Thomas L. Chenevert¹, Brian D. Ross¹, Alnawaz Rehemtulla¹
¹University of Michigan, Ann Arbor, Michigan, USA; ²University of Michigan Medical Center, Ann Arbor, Michigan, USA

To evaluate a novel Gene Dependent Enzyme Prodrug Therapy (GDEPT) for glioma, genetically engineered rat glioma cells were developed which expressed either a fusion protein between Saccharomyces cerevisiae cytosine deaminase (CD) and Haemophilus influenzae Uracil phosphoribosyltransferase (UPRT) or just CD alone. The activity of these proteins and their therapeutic efficacies were then followed in vitro and in vivo using both 19F MRS and diffusion weighted MRI.

13:44  **1243. Tension of White Matter Tracts Measured by Diffusion Tensor Magnetic Resonance Imaging**

Yaniv Assaf¹, Pazit Pianka¹, Liat Ben-Sira¹, Dafna Ben-Bashat¹, Talma Hendler¹, Orna Aizenstein¹, Liana Ben-Adami², Shlomi Constantini²
¹Tel Aviv Sourasky Medical Center, Tel Aviv, Israel

Pressure to the white matter may lead to axonal degeneration and significant patient disability. We have studied here the diffusion characteristics of white matter affected by mechanical pressure in extra-axial tumors and hydrocephalus. We found that the diffusion parallel to the fibers is increased when the fibers are tensed. The diffusion perpendicular to the fibers was found to decrease as a result of high packing of the fibers. These two changes lead an overall increase in the fractional anisotropy and no apparent change in ADC. These measurements might help to estimate the effect of high intracranial pressure on white matter.
Conductivity imaging of the rat brain were obtained using diffusion tensor MRI. Based on the proportionality relation between conductivity and the diffusion coefficient, we formulated the relation between tissue conductivity and the signal intensity of diffusion-weighted images. Images were obtained with b factors up to 3600 s/mm². Conductivity tensor images were calculated from images of the fast component of ADC and images of the fast component fraction. In the ROIs located in the cortex and the corpus callosum, the mean conductivities (MCs) were 2.5x10⁻² S/m and 2.9x10⁻² S/m, respectively, and the fractional anisotropies (FAs) were 0.46 and 0.50, respectively.

Effect of Dipolar Coupling on the $T_1\rho$ MRI Signal in the Mouse Brain

The residual dipolar coupling can be probed by the $T_1\rho$ (or the spin-lattice relaxation time in the rotating frame) MRI signal. $T_1\rho$ spectra obtained from the mouse head in vivo indicated the presence of multiple dipolar frequency components. Outer-volume suppression techniques were used to isolate the frequency components from the brain.

Diffusion in Healthy and Diseased Brain

Amyotrophic lateral sclerosis (ALS) involves motor neurons, but sensory system remains uninvolved. Various MR techniques have been used in evaluating ALS[1, 2]. DTI has also been used in the assessment of CST in ALS patients[3]. On conventional MR imaging, CST shows normal or abnormal signals in ALS patients, but thalamic ventral posterior lateral (vpl) nucleus, knowing as an area of sensory tract structure, appears to be normal in all ALS patients. This work quantitatively evaluates the motor and sensory areas in both ALS and control group by using DTI fractional anisotropy (FA) and relative anisotropy (RA) measurements.

We assessed water diffusion changes along pyramidal tracts of brainstem in amyotrophic lateral sclerosis (ALS). By the quantitative measurements of overall diffusivity and anisotropy from DTI, we investigated correlations between the changes of diffusion properties and the clinical extent of upper motor neuron signs (UMN). We found a significant decrease of FA in patients compared with normals in the midbrain, but not in the pons and medulla. And a strong negative correlation between FAs in the cerebral peduncle and the clinical extent of UMN signs supports the potential role of DTI for detecting and monitoring the UMN involvement in ALS.

Changes of fractional anisotropy (FA) in early amyotrophic lateral sclerosis (ALS) were investigated by a voxel based analysis (SPM99) without any a priori hypothesis. Changes of the metabolites in the motor area were also compared. Nine patients and 10 controls were investigated. Using voxel based morphometry, the FA of the corticospinal tract in the region of the semiovale center was significantly reduced in ALS. The metabolites in the motor area were the same for ALS and controls. Thus, axonal pathology seems to precede metabolic changes in the motor area in early ALS.
Factors Associated with Loss of White Matter Anisotropy in Post-Treatment Medulloblastoma Survivors

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We evaluate effects of age at cranial irradiation, time interval since irradiation and irradiation dose on white matter anisotropy in childhood medulloblastoma survivors by computing white matter fractional anisotropy (WM FA) using SPM post-processing functions. Mean percentage change in WM FA of patients compared to controls was -4.4% (sd=7.6%). Using Spearman’s correlation, there were significant associations between percentage reduction of WM FA and age at cranial irradiation (r=0.673, p=0.002) and irradiation dose (r=-0.723, p=0.001), but not with time interval since irradiation. Multivariate regression analysis confirmed that both factors correlated significantly with percentage reduction of WM FA (adjusted r2=0.516, p=0.001).

Diffusion Tensor Imaging Provides Evidence of Brain Involvement in “Pure” Adrenomyeloneuropathy Patients

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Adrenomyeloneuropathy (AMN), a neurological disorder commonly affecting the spinal cord long tracts, except in about 20% patients, who develop overt brain demyelination. The rest 80% are commonly referred to as “Pure AMN”. Diffusion tensor imaging (DTI) can detect neuronal tract ultrastructural abnormalities. We employed DTI to study brain involvement in “Pure AMN”. Results indicated lowered fractional anisotropy in internal capsule, corona radiata, frontal and parietal white matter, with no significant differences in mean apparent diffusion coefficient (mADC) except for corona radiata, which also showed abnormality of mADC suggesting occult cerebral disease process in the form of damaged neuronal integrity.

Brain Tissue Damage in Dementia with Lewy Bodies: A Diffusion Tensor MRI Study In Vivo

Marco Bozzali1, Andrea Falini1, Mara Cercignani1, Elisabetta Farind1, Margherita Alberoni1, Francesca Baglio1, Paolo Vezzulli2, Fabrizio Olivotto1, Federica Mantovani1, Nicola Canal1, Raffaello Nemni1

1Don Carlo Gnocchi Foundation, Milan, Italy; 2Scientific Institute and University Ospedale San Raffaele, Milan, Italy; 1Institute of Neurology, London, UK

DTI was applied to a group of 11 patients with Dementia with Lewy bodies (DBL) compared to 8 sex- and age-matched healthy volunteers in order to assess the presence and the distribution of microscopic tissue damage in DBL. A region of interest analysis was used to quantify mean diffusivity and fractional anisotropy values in several brain areas. Microscopic abnormalities were mainly found in the corpus callosum and pericallosal areas, in the parietal, occipital lobes and in the caudate nucleus. These findings might potentially represent neuro-radiological markers of DBL and could contribute to clarify the pathophysiology of this disease.

Tractography of Callosal Dysgenesis

Harushi Mori1, Yoshitaka Masutani2, Shigeki Aoki2, Hiroshi Oba1, Kazuhiro Tsuchiya4, Naoto Hayashi1, Osamu Abe2, Tomohiko Masumoto1, Haruyasu Yamada1, Takeharu Yoshikawa2, Akira Kunimatsu2, Kuni Ohtomo2

1University of Tokyo Hospital, Tokyo, Japan; 2University of Tokyo, Tokyo, Japan; 3Teikyo University, Tokyo, Japan; 4Kyorin University, Tokyo, Japan

Diffusion tensor imaging (DTI) is a unique MR technique to analyze diffusion anisotropy of the brain. The purpose of this study is to visualize and analyse the neural anatomy in patients with callosal dysgenesis. DTI of the brain was performed in 10 patients by a 1.5T MRI system using a 6-axes single-shot echo planer imaging (EPI). Deterioration collection software was employed for the EPI technique. Tractography was generated with our original software. Probst's bundle was clearly illustrated by tractography. The tracts running through anterior commissure were independent of Probst's bundles. Tractography is useful to analyze in vivo brain structures.

Reduced Diffusion Anisotropy in Schizophrenia: A Voxel-Based Diffusion Tensor MR Study

Haruyasu Yamada1, Osamu Abe2, Kiyo Kasa1, Hidenori Yamasue1, Shigeki Aoki2, Takeharu Yoshikawa2, Akira Kunimatsu2, Hiroyuki Kabasawa2, Harushi Mori1, Tomohiko Masumoto1, Naoto Hayashi1, Nobumasa Kato1, Kuni Ohtomo2

1University of Tokyo, Bunkyo-ku, Tokyo, Japan; 2GE Yokogawa Medical System, Hino, Tokyo, Japan

The purpose of this study is to investigate diffusion anisotropy in schizophrenic brain by voxel-based analysis of DTI in our institute, using statistical parametric mapping (SPM). We studied 32 patients with schizophrenia diagnosed by DSM-IV criteria, and 42 age-matched controls. The significant FA decrease in the patient group was found in the parahippocampal white matter (WM) of the bilateral limbic lobes, middle frontal WM of the right frontal lobe, and so on. No significant increased region was noted. Our result may reflect reduced diffusion anisotropy of the white matter pathway of the limbic system as decreased FA indices.
14:08  **1254. Prognostic Utility of Diffusion Tensor Imaging and MR Tractography in Stroke Patients**

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1National Neuroscience Institute, Singapore, Singapore

Diffusion tensor imaging was performed in six patients with cerebral infarctions (four ischemic, two haemorrhagic) on a 3T scanner to assess the structural involvement and degeneration of white matter tracts in the region of infarct, and examine its potential relevance towards patient outcome. Fractional anisotropy of the white matter tracts in the region of infarction and MR tractography was performed. Clinical outcome of the patients was related to the preservation of long white matter fibre tracts in the region of infarct. These new techniques provide an imaging correlate of tract preservation or disruption, with prognostic implications on stroke outcome.

14:09  **1255. Application Study of DTI and fMRI in the Rehabilitation of Ischemic Stroke Patients with 3T**

Xiang Liu, Jian ping Dai, Wei Tian, Wei Sun, Fei Sun, Shao wu Li, Guang Cao

1Beijing Neurosurgical Institute, Beijing, People's Republic of China; 2PKU 3rd Hospital, Beijing, People's Republic of China; 3GE Medical System, Beijing, People's Republic of China; 4GE Medical System, HongKong, People's Republic of China

Rehabilitation therapy is important for stroke patients to recover their motor ability, but the mechanism of brain compensation and imaging criteria for prognosticating rehabilitation treatment effect are unclear. Our result suggests different brain area compensation result in different degree of hand motor ability recovery; the severity of disruption of the cortical spinal cord may be used to predict the prognosis of rehabilitation treatment. DTI and fMRI are useful for the exploration the mechanism of rehabilitation.

14:10  **1256. Three-dimensional Relationship between the Corticospinal Tract and Infarcts of the Lateral Striate Arteries Territory using Tractography**

Junya Konishi, Kei Yamada, Osamu Kizu, Hiroshi Ito, Yasushi Kaji, Masahiko Fujii, Kazurou Sugimura, Tsunehiko Nishimura

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Patients with infarcts in the lateral striate arteries (LSA) territory often experience motor disturbance, which may indicate that infarcts involve the corticospinal tract (CST). Using tractography, we evaluated the anatomical relationship between the LSA territory and the CST in 16 patients with acute or chronic infarcts, and clarified the clinical correlation between the location of infarcts and the CST by dividing this territory into four segments. The CST was found to cross the LSA territory only at the posterosuperior segment. All infarcts at the posterosuperior segment not only had involvement of the CST, but also had severe motor symptoms.

14:11  **1257. Quantification of Fronto-Occipital and Thalamo-Frontal Connectivity in Alzheimer's Disease by DTI-Tractography**

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There is evidence from electroencephalography (EEG) that the fronto-occipital connections should be preferentially disrupted in Alzheimer's Disease (AD). Using DTI-tractography, the fronto-occipital connectivity in four AD and four normal controls (NC) was quantified in terms of a normalized tract-count and average fractional anisotropy (FA) along the tracts, and compared to the same measures for the thalamo-frontal connectivity. The corresponding effect sizes (Fronto-occipital tract-count: 1.05, average FA: 0.65; Thalamo-frontal tract-count: 0.66, average FA: 0.78) suggest that the tract-count of the fronto-occipital tracts would be a sensitive measure to separate AD from NC.

14:12  **1258. The Diagnostic Value of Template-Derived Regional DTI Metrics in Mild Cognitive Impairment and Alzheimer’s Disease**

Philipp G. Sämann, Nibal Ackl, Yvonne Schreiber, Susanne Heim, Annette Sonntag, Dorothee P. Auer

1Max-Planck-Institute of Psychiatry, Munich, Germany

Diffusion tensor imaging can non-invasively and reliably measure microstructural alterations of brain tissue and has proved useful for the characterization of neurodegenerative diseases. In Alzheimer's disease (AD) diffusivity and anisotropy seem to be modulated by the underlying neurobiological processes, making them candidates for surrogate markers. We probed the usefulness of regional histogram-based diffusivity markers for the characterization of the disease progress in terms of clinical stages (controls, mild cognitive impairment [MCI], AD) and cognitive functioning. Histogram analysis separated mild AD, but not MCI from controls. Significant interrelations with memory tests were found across groups, especially for temporomesial parenchymal diffusivity.
**14:13  1259. A White Matter Tractography Study of White Matter Reorganization after Surgical Resection of Brain Neoplasms**

Mariana Lazar1, Paul Thottakara1, Aaron S. Field1, Bryan Laundre1, Behnam Badie1, Brian Jellison1, Andrew L. Alexander1

1University of Wisconsin, Madison, Wisconsin, USA

White Matter Tractography (WMT) using DTI is a promising method for non-invasively estimating the patterns of WM connectivity in the human brain. Recent studies have shown that WMT is able to estimate major WM structures in both healthy subjects and tumor patients. Here, WMT was used to visualize tract preservation and reorganization in six tumor patients after the surgical resection of the tumors. Tracts that were investigated included the corticospinal tract, corona radiata, arcuate fasciculus, cingulum bundles, and corpus callosum. In all cases, the WMT results appeared to depict the impact of tumors and surgery on the WM organization.

**14:14 1260. Comparison of Fiber Tracking Techniques in Combination with Functional Localization in Brain Tumor Patients**

Jeffrey I. Berman1, Srikantan S. Nagarajan1, Mitchel S. Berger1, Roland G. Henry1

1UC San Francisco, San Francisco, California, USA

DTI fiber tracking is used in combination with magnetic source imaging (MSI) and direct cortical stimulation to delineate pyramidal and somatosensory subcortical pathways. This study uses both streamline and probabilistic fiber tracking techniques to evaluate their utility in combination with functional localization in tumor patients. Probabilistic fiber tracking more often showed connectivity through crossing fibers from MSI cortical sites than the streamline method. Fiber tracking from MSI and stimulation sites is clinically important because the technique can determine which margins of a tumor are closest to the pyramidal tract and somatosensory radiation.

**14:15 1261. Spontaneous Recovery Following Spinal Cord Injury: In Vivo Longitudinal Diffusion Tensor Imaging Studies**

Ponnada A. Narayana1, Ibrahim Elshafiey2, Bilgen Mehmet3

1University of Texas at Houston, Houston, Texas, USA; 2Cairo University, Cairo, Egypt; 3Kansas University Medical Center, Kansas City, Kansas, USA

In vivo, longitudinal changes in the diffusion tensor measures in experimental spinal cord injury in rats were investigated over a period of 8 weeks. The estimated anisotropy at caudal segment that is 5 mm away from the epicenter of injury was observed to sharply decline immediately after injury but continued to improve and peaked around 2 to 3 weeks post-injury. This temporal behavior of anisotropy paralleled to the neurobehavioral scores. These studies suggest spontaneous recovery following spinal cord injury.

**14:16 1262. Diffusion Imaging of Human Vertebrae In Vivo with a Non-CPMG Single Shot Fast Spin Echo Technique**

Jingfei Ma1, Ken-Pin Hwang2, Ashok Kamar1, Jason Polzin2, Graeme McKinnon2, Patrick Le Roux1

1University of Texas M. D. Anderson Cancer Center, Houston, Texas, USA; 2GE Medical Systems, Waukesha, Wisconsin, USA; 3GE Medical Systems, Buc, France

A diffusion-weighted non-CPMG single shot fast spin echo pulse sequence was used to image vertebrae of a healthy volunteer and a patient with metastasis. The pulse sequence uses quadratic phase modulation to the refocusing RF pulses. Advantages of the technique include relatively high signal-to-noise and insensitivity to magnetic field inhomogeneity and patient motion. Preliminary results indicate that artifact-free diffusion-weighted images of human vertebrae can be readily obtained. The computed ADC (apparent diffusion coefficient) values may be useful in differentiating benign from malignant vertebral compression fractures.

**14:17 1263. Diffusion Tensor MRI and Fiber Tractography in Malformations of Cortical Development**

Seung-Koo Lee1, Susumu Mori1, Jinna Kim1, Young Joon Lee1, Dong Ik Kim1

1Yonsei University College of Medicine, Seoul, Republic of Korea; 2Johns Hopkins University, Baltimore, Maryland, USA

We examined the patients with malformations of cortical development (MCD) by diffusion tensor MRI (DTI) and fiber Tractography (FT). DTI showed different FA values of heterotopic gray matter and FT demonstrated aberrant fiber connections in MCD. DTI & FT is useful in the evaluation of white matter abnormality and understanding pathogenesis of MCD.

**14:18 1264. Combined DTI and Functional Connectivity Assessment of Cerebral Neoplasia**

Song Lai1, Jianrong Shi1, Maolin Qiu1, Arthur Pinkerton2, Robert Dowsett1

1Thomas Jefferson University, Philadelphia, Pennsylvania, USA; 2UConn Health Center, Farmington, Connecticut, USA

DTI and functional connectivity (FC) assessment were carried out on 7 brain tumor patients. FC maps were constructed using correlation of low frequency (< 0.1 Hz) spontaneous temporal fluctuation of BOLD signals. Three distinct patterns were observed: 1) when white matter (WM) fibers were not apparently affected by a lesion, FC was largely maintained; 2) when a lesion caused displacement of WM tracts without significantly affecting diffusion anisotropy, FC was found to be correspondingly distorted; 3) when WM tracts were disrupted, FC disappeared too. These results provided evidence that DTI can be used to examine structural connectivity underlying functional connectivity.
Periventricular leukomalacia (PVL) is a sequela of hypoxic-ischemic insult in premature infant. We report the correlative study of fiber tractography by diffusion tensor-MRI and FDG-PET of PVL, comparing conventional MR findings in an 8-year-old patient. Diminished periventricular white matter volume of the parietooccipital area was demonstrated on T2-weighted images and fiber tractography. Fiber tractography also revealed thinning of the association fiber connected to and from the right temporal lobe. FDG-PET showed decreased glucose uptake of the right temporal cortex. Integration of imaging findings of gray and white matters might facilitate comprehension of the underlying neuropathophysiology in patients with PVL.

In order to determine whether the brain continues to mature in early adulthood, eighteen healthy volunteers in their twenties and thirties were studied using a diffusion tensor MRI technique. From the diffusion tensor data set, histograms of mean diffusivity (MD) and fractional anisotropy (FA) were obtained. Significant positive correlation with age was seen in mean FA value and significant negative correlation with age was seen in FA peak height, which may reflect the progression of myelination and/or the relative increase of white matter volume. Our preliminary results suggested that the brain continues to mature in early adulthood.

Methods for determining the orientations of crossing fibres are used with streamline fibre tracking in 11 normal volunteers. Tracking is constrained to fibres passing through Broca’s and Wernicke’s areas and homologous regions in the contralateral hemisphere. Maps of group connection variability indicate connection via the superior longitudinal fasciculus in both hemispheres, and bilateral connectivity to area 40. Additional connections are observed in the passing through Broca’s and Wernicke’s areas and homologous regions in the contralateral hemisphere. The lateralisation index of connecting volumes is 0.33, indicating more connective structure in the left hemisphere.

Brain structural changes associated with normal aging lead to alterations in water diffusivity measurements. Previous work revealed age-related declines in white matter anisotropy with analysis of specified regions-of-interest. In this work, we investigated mean diffusivity and diffusion anisotropy in the brains of normal aging population using voxel-wise statistical analysis. In addition, a study of white matter tractography was performed to help understanding anatomical connectivity of white matter tracts which were altered with normal aging.

Methods for determining the orientations of crossing fibres are used with streamline fibre tracking in 11 normal volunteers. Tracking is constrained to fibres passing through Broca’s and Wernicke’s areas and homologous regions in the contralateral hemisphere. Maps of group connection variability indicate connection via the superior longitudinal fasciculus in both hemispheres, and bilateral connectivity to area 40. Additional connections are observed in the dominant hemisphere including a possible connection between Broca’s area and Wernicke’s area via the external capsule. The lateralisation index of connecting volumes is 0.33, indicating more connective structure in the left hemisphere.

For an integrated understanding of the brain’s functional architecture, in vivo correlation between functional areas and the pattern of neuronal connectivity is necessary. Such correlation studies were difficult to perform in the past, however, as most anatomical techniques necessitated invasive and/or terminal procedures. In the present study, we used the technique of the Diffusion Tensor Magnetic Resonance Imaging (DT-MRI) in combination with high-resolution functional MRI in Human high order visual area.
Diffusion Imaging at 3.0T with Sensitivity Encoding: Intra-Individual Comparative Clinical Study
Christiane K. Kuhl, Juergen Gieseke, Jochen Textor, Christiane Sonntag, Sunhild Gernert, Hans H. Schild
1University of Bonn, Bonn, Germany

We performed an intra-individual comparative trial to investigate the impact of parallel imaging (SENSE) for diffusion imaging (DWI) at 3T in terms of image quality and presence of artifacts, SNR, CNR, and clinical reading of DWI studies in 85 patients presenting for work-up of suspected ischemic stroke. The results show that SENSE significantly reduces susceptibility artifacts, image blurring and gross distortions in sh-DWI at 3.0T. This translates into a significant increase regarding the diagnostic confidence with which ischemic DWI lesions can be demonstrated or excluded.

White Matter Differences in Divers versus Other Off-Shore Workers: A Diffusion Tensor Imaging Study
Gordon D. Waiter, Alison D. Murray, John A. Ross, Jennie MacDiarmid, Claire L. Taylor, John R. Crawford
1University of Aberdeen, Aberdeen, UK; 2University of St Andrews, St. Andrews, UK

The long-term health effects of diving have been studied with a number of groups reporting an increase in white matter lesions in divers compared to controls. We report diffusion tensor imaging data on 10 divers. A voxel by voxel analysis of the brain identified fractional anisotropy decreases relative to 10 age matched controls. Significant reductions in fractional anisotropy were found in divers compared with control subjects, bilaterally in the posterior limb of the internal capsule, in the pre-central gyrus of the right frontal lobe, and the left precuneus.

Determination of Neuron Fiber Orientation and Structure with Highly Angular-Resolved Diffusion Attenuated Imaging and Analysis
Xi Li, Jianming Zhu, Hong Li, Miao Hua Jiang
1Wake Forest University School of Medicine, Winston-Salem, North Carolina, USA; 2Wake Forest University, Winston-Salem, North Carolina, USA

Conventional DTI method uses a single-tensor (fiber-direction)-per-voxel model, and has limitations to determine and resolve fiber orientations for voxels with multiple crossings. Some new tensor models have been proposed recently to overcome the limitations of the single-tensor-per-voxel model, but they retain the pitfalls of tensor models, and multiple tensor components are estimated and derived through various optimization methods. In this work, we proposed a new method to determine the neuron fiber orientation and structure based on highly-angular-resolved diffusion attenuated imaging and analysis.

Application of the Laplace Transform to Analyze Intravoxel Fiber Structures in Diffusion MRI
Ruiwang Huang, Oleg Posnansky, Karl Zilles, N Jon Shah
1Institute of Medicine, Research Center Juelich, Juelich, North-Westfalia, Germany

The Laplace transform (LT) has been used to analyze fiber bundles in a voxel by applying diffusion MRI theoretically. From the LT results, it is possible to determine the number of fibers in a given voxel. The LT method can be thought as a complimentary method to HARD (high angular resolution diffusion-weighted) acquisition method to detect the fiber distribution in a voxel.

Adaptive Bayesian Tracking of Neuronal Fiber Pathways from Diffusion Tensor Images
Yonggang Lu, Zhaohua Ding, John C. Gore, Adam W. Anderson
1Vanderbilt University Institute of Imaging Science, Nashville, Tennessee, USA

This study aims at developing a novel fiber tracking algorithm robust to noise and partial volume averaging in diffusion tensor images. By extending the classical Bayesian decision theory, an adaptive Bayesian fiber tracking framework is established, wherein Gaussian functions are employed to model a priori and conditional probabilities and weighting factors adaptive to local diffusion anisotropy are imposed to these probabilities. Results of simulated and in vivo human brain data show that, compared to the streamline and classical Bayesian methods, this novel adaptive method achieves a better performance in the presence of noise and partial volume effect.
13:33  **1276. Towards a Marriage of Deterministic and Probabilistic Tractography Methods:**

**Bootstrap Analysis of Fiber Trajectories in the Human Brain**

Derek K. Jones\(^1\), Carlo Pierpaoli\(^2\)

\(^1\)National Institutes of Health, Bethesda, Maryland, USA

The bootstrap technique is an extremely powerful non-parametric statistical procedure for determining the uncertainty in a given statistic. However, its use in DT-MRI tractography remains virtually unexplored. We show how it provides qualitative ‘probabilistic’ insights into deterministic approaches, and underline the important effect of local fiber architecture on tracking reproducibility. Not only does the bootstrap allow any deterministic tractography algorithm to be used in a probabilistic fashion, but its model-free inclusion of all sources of variability (including those that cannot be modeled) means it provides the most realistic approach to probabilistic tractography.

13:34  **1277. Comparison of Flow- and Streamline-Based Fibre Tracking Algorithms using an Anisotropic Diffusion Phantom**

Jennifer Shane Williamson Campbell\(^1\), Vladimir Ryma\(^1\), Abbas S. Sadikot\(^1\), Kaleem Siddiqui\(^2\), G. Bruce Pike\(^1\)

\(^1\)Montreal Neurological Institute, Montreal, Quebec, Canada; \(^2\)McGill University, Montreal, Quebec, Canada

The goal of this study was to compare the performance of flow- and streamline-based fibre tractography algorithms using real diffusion MRI data. In doing so, we designed a physical anisotropic diffusion phantom with known connectivity. Additionally, we developed a method for quantitatively comparing the results of multiple tracking algorithms given any ‘gold standard’ connectivity map. We demonstrate the potential for the flow-based algorithm to map connections in regions of subvoxel partial volume averaging of fibre directions, which can be difficult to map with the streamline-based method.

13:35  **1278. Classification of Fibre Tracts Using Differential Geometry**

Philip G. Batchelor\(^1\), Fernando Calamante\(^1\), David Atkinson\(^1\), Donald Tournier\(^2\), Alan Connelly\(^2\), Derek L.G. Hill\(^1\)

\(^1\)Kings College London, London, UK; \(^2\)University College London, London, UK

Most fibre tracking studies in DT-MRI simply display the reconstructed fibres, and no information is usually calculated from them, which limits their clinical use. One of the main reasons for the limitation is that the shape of the tracts is not directly quantified. We propose to use tools from Differential geometry to quantify the shape of fibres. These tools will allow intersubject comparison of individual curves, without the need for image normalisation. We also use the Link (inspired from DNA and polymer folding analyses) to study relative spatial configurations of curves/fibres. We apply this method to three in vivo datasets.

13:36  **1279. Mapping the Orientation of Intra-voxel Crossed Fibers Based on the Phase Information of the Diffusion Circular Spectrum**

Wang Zhan\(^1\), Elliot A. Stein\(^1\), Yihong Yang\(^1\)

\(^1\)National Institutes of Health, Baltimore, Maryland, USA

The diffusion circular spectrum mapping (DCSM) was recently proposed to solve the problem of determining the uncertainty in a given statistic. However, the orientation of the intra-voxel fiber-crossings remained unknown. The present study aims to solve this problem by utilizing phase information of the 4th order circular spectrum to estimate the orientation of the intra-voxel crossed fibers. Both computer simulations and diffusion MRI experiments were conducted to validate this method. Results indicated that the estimated intra-voxel crossed fibers shown a clear consistency with the surrounding fiber tracks. This method could be used to improve current fiber-tracking techniques in the presence of fiber crossings.

13:37  **1280. Potential of Fiber Tracking and Connectivity Mapping with Multi Diffusion Tensor**

Bjoern Wolf Kreher\(^1\), J. FL Schneider\(^1\), Irina Mader\(^1\), E. Martin\(^1\), Juergen Hennig\(^1\), Kamil A. Il'yasov\(^1\)

\(^1\)University Hospital, Freiburg, Germany; \(^2\)University Children's Hospital, Zuerich, Switzerland; \(^3\)Neurocenter of the University Hospital, Freiburg, Germany

Most tracking algorithms for determination of neuronal fiber pathways in the brain are based on diffusion tensor imaging (DTI). The standard DTI method using only one single diffusion tensor (singleDT) is inappropriate for fiber crossings. However, the Multi-Diffusion-Tensor approach (MDT) is able to detect the directions of crossing fibers. A probabilistic and the FACT algorithm were extended to support the MDT-model. Application of these tracking algorithms on corticalspinous tracks show that MDT is more stable in regions with fiber crossings and allows the detection of connections to the gyrus pre- and postcentralis.

13:38  **1281. RBF-Based Reconstruction of Fiber Orientation Vector Field for the White Matter Fiber Tract Modeling**

Yoshitaka Masutani\(^1\), Shigeki Aoki\(^1\), Osamu Abe\(^1\), Kenji Ino\(^1\), Kuni Ohtomo\(^1\)

\(^1\)University of Tokyo Hospital, Tokyo, Japan

The fiber tracking technique based on MR-DTI is a powerful tool for visualizing structures of the fiber tracts in the brain white matter. One of the most important problems in the fiber tracking is error in determining tracking direction at a fiber crossing part due to partial volume effect. In this abstract, we introduce our novel approach for fiber tract modeling across such crossing part by using a vector field interpolation technique based on radial basis function. Quantitative studies were performed for proving feasibility of our technique by analyzing errors in estimating vector field of fiber tract orientation.
Unsupervised Fiber Reconstruction of Distinct Anatomical Structure using Diffusion Tensor MRI

Reconstruction of neuronal fiber pathways of distinct anatomical structure in vivo as a technical problem has been the focus of many recent studies. However, most studies visually or manually combined the fiber pathways to bundle fibers. We propose a new general approach to unsupervised reconstruct neuronal fiber pathways with distinct anatomical structure using DTI. Fiber tracking, fiber similarity estimating, and starting point detecting are interactively executed, until no new starting point is selected. Results demonstrate that the method is convenient, accurate and reproducible. The method is a promising tool for analyzing the connectivity of brain regions and studying disease.

A Comparison of White Matter Fiber-Tracking Results Using PROPELLER and SE-EPI Datasets

White matter fiber-tracking using conventional, EPI-based, Diffusion Tensor Imaging (DTI) is affected by susceptibility artifacts. In contrast, PROPELLER-DTI provides diffusion images that are free of such artifacts. In this study, fiber-tracking is performed using SE-EPI-DTI and PROPELLER-DTI. In brain regions distant from areas of significant susceptibility differences, PROPELLER provided similar fibers as SE-EPI. However, in the frontal and temporal lobes, fiber tracts based on SE-EPI acquisitions were uncoherent, distorted and oftentimes missing due to signal loss. Fiber tracts based on PROPELLER acquisitions were robust, undistorted and matched corresponding anatomy throughout the brain.

Brain White Matter Tractography from DT Images Using Global Coverings and Maximal Likelihood Connectivity

This paper presents a novel method for determining the loci of fibre tracks from diffusion tensor images based on a global covering of the image. The global covering is calculated as a field of overlapping Gaussians, shaped and oriented according to the diffusion tensor parameters. Fibre tracks are assumed to follow the ridges in the global covering map, and are calculated using a modified Dijkstra shortest path algorithm. This algorithm is inherently noise insensitive, and because it is globally based, paths between voxels are not constrained by the choice of seed point.

Fibre Tracking on q-Space Data

Tracking axonal bundles in brain white matter based on water diffusion tensor data faces problems in regions where fibres cross. In such regions the fibre directions cannot be inferred from the measured apparent diffusion tensor. This difficulty can be addressed by fibre tracking which is based on a measurement of the water displacement probability density function, i.e. on data from 3-dimensional q-space imaging.

Mapping White Matter Connectivity with BOLD Activated Regions Using Diffusion Spectrum Imaging and fMRI

Tractography based on diffusion tensor imaging (DTI) produces incomplete tracing if complex fiber crossing is encountered along the tracts. To address this problem, diffusion spectrum imaging (DSI) was proposed by mapping the probability density function of water molecular diffusion. In this study, we combined DSI tractography and functional MRI to demonstrate the white matter connectivity in the functioning human brain. From the DSI data, tractography was not interrupted in the regions of complex fiber crossing. The BOLD activation was closely connected to efferent corticospinal tracts. In conclusion, DSI tractography is potentially useful to study functional connectivity in the human brain.

fMRI Based Fiber Tracking using SENSE-DTI at 3 Tesla

Diffusion tensor (DT)-fiber tracking algorithms allow to reconstruct the 3D-architecture of the major white matter tracts in-vivo. Functional MRI (fMRI)-based fiber tracking holds great promise for better understanding the functional connectivity of the human brain. In this work, we demonstrate the use of fMRI-evoked tractography using SENSE-DTI-data acquired at 3 Tesla. The results of reconstructed fibers in a volunteer and a patient suffering from an arteriovenous malformation are compared and presented in a 3D-environment. It is shown that the newly implemented tracking algorithm (based on the tensor deflection method) improves the results in regions in which fiber crossing occurs.
Towards a Unique Segmentation Map of Seed Points for Generation of White Matter Pathways

Ian Nigel Lawes1, Thomas Richard Barrick1, Chris Alan Clark1
1St George's Hospital Medical School, London, UK

Generation of fibre pathways by diffusion tensor imaging requires a considerable investment of time and anatomical expertise. Here we present a method for creating a whole-brain map of seed points (voxel centres) that generate segmented fibre pathways based on user-defined anatomical labels. This technique removes the need for ROI placement. It involves repeated application of a region growing algorithm (RGA) that segments white matter pathways from single user-defined voxels until all voxels are assigned. This labelling process identifies all voxels that generate fibre tracks throughout the entire brain and provides a map of seed points from which pathways are reconstructed.

Assessment of Early Diffusion Changes in Wallerian Degeneration with Three-Dimensional Fiber Tractography

Akira Kunimatsu1, Shigeki Aoki1, Yoshitaka Masutani1, Osamu Abe1, Naoto Hayashi1, Tomohiko Masumoto1, Harushi Mori1, Kuni Ohtomo1, Hiroyuki Kabasawa1
1Graduate School of Medicine, University of Tokyo, Tokyo, Japan

We measured fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values of corticospinal tract affected in infarction with the assistance of three-dimensional diffusion tensor fiber tractography (3D-DTT) in order to assess early diffusion changes in Wallerian degeneration. In a location that was 1cm distant from the infarct, anisotropic diffusion of CST began to decrease in 6 to 10 days after stroke onset while isotropic diffusion did not obviously change. 3D-DTT seems useful in detecting and evaluating of initial diffusion abnormalities in Wallerian degeneration.

Lateral Asymmetry of Superior Longitudinal Fasciculus: A White Matter Tractography Study

Mariana Lazar1, Aaron S. Field1, Jong Hoon Lee1, Andrew L. Alexander1
1University of Wisconsin, Madison, Wisconsin, USA

White Matter Tractography with DTI was used to study the superior longitudinal fasciculi of the right and left hemisphere in ten right-handed, healthy subjects. The volume of tracts connecting the frontal and temporal lobes was measured in both right and left hemispheres of each subject. Lateral morphometric asymmetry was found in all the subjects, with the left white matter volume being larger than the right white matter volume. The larger tract volume of the left SLF may be related to left-hemisphere dominance for language. Non-invasive methods for lateralizing language function would be valuable for minimizing language deficits from surgical interventions.

DTI-based Parcellation of White Matter: Application to the Corpus Callosum

Hao Huang1, Hangyi Jiang1, Setsu Wakana1, Lidia Poetscher1, Jiangyang Zhang1, Michael I. Miller1, Peter C.M. van Zijl1, Susumu Mori1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

DTI has been a powerful technique to delineate intra-white matter architecture. However, structures within large fiber bundles, like corpus callosum (CC), can not be divided further without incorporating distant cortical connectivity information. With DTI fiber tracking, the CC was parceled into six sub-regions based on its trajectories into orbital, frontal, parietal, occipital, temporal lobes and subcortical nuclei. In this group research, the functional partition of CC map based on the cortical connectivity and standard deviation map of inter-subject CC deformation vectors are presented, which suggest some anatomical findings. This technique may provide a new tool into the CC morphology studies.

Manganese-Enhanced MRI Tracing of Laminar Specific Functional Thalamo-Cortical Connections in Rat

Afonso C. Silva1, Galit Pelled1, Alan P. Koretsky1
1National Institutes of Health, Bethesda, Maryland, USA

MnCl2 as a tracer of the direct pathway between the thalamus and the rat somatosensory cortex was tested to detect specific laminar input. T1-weighted manganese-enhanced MRI of the rat brain was acquired approximately 16 hours after MnCl2 injection to thalamus. An overall increase in intensity could be observed in somatosensory cortex compared to other brain regions. Maximum intensity projection images calculated from T1-weighted images revealed a distinctly bright stripe located 600-700 µm below the pial surface, along the expected anatomical location for lamina IV. Our results suggest that MEMRI is capable of detecting the initial stages of cortical input.
13:31 1293. Neuronal Tract Tracing By Manganese Enhanced MRI (MEMRI) In Kainate Model of Epilepsy
Jaak Nairismägi1, Olli H.J Gröhn1, Susanna Narkilahti1, Asla Pitkänen1, Risto A. Kauppinen2
1University of Kuopio, Kuopio, Finland; 2University of Manchester, Manchester, UK

The study was designed to investigate changes of neuronal tracts in epileptic adult rats using Manganese enhanced MRI (MEMRI). Control animals showed MEMRI signal in all subfields of ipsilateral hippocampus. Epileptic rats displayed enhanced signal in hippocampus, particularly in the hilus and CA3 corresponding to course of mossy fiber pathway. Additionally, epileptic animals had stronger MEMRI signal in the dorsal thalamus. Use of trans-neuronal tracers may provide a useful tool to detect activity-induced alterations in hippocampal mossy fiber pathway.

13:32 1294. Anatomic and Functional Organizations in Developing Neonatal Rat Brain Revealed by Manganese Enhanced MRI and 1H-MRS
Keun Ho Lim1, Ki Soo Kim1, Sang Tae Kim1, Jung Hee Lee1, Yun Yi2
1Asan Institute for Life Sciences, Seoul, Republic of Korea; 2Korea University, Seoul, Republic of Korea

MEMRI is a newly emerging technique that can be used for mapping anatomic and functional organizations of the brain. Conventional imaging technologies have limitations to image the fine anatomic structures during neonatal period. In this study, we employed MEMRI to investigate the formation of the anatomic structures as a function of time and to monitor functionally active cells during the neonatal period. 1H-MRS was employed in conjunction with MEMRI to monitor the potential toxicity of Mn2+ in the brain. MEMRI with 1H-MRS seems to be a useful method to investigate various neurological diseases involved with neonatal brain.

Takashi Kondoh1, Ryoko Shibata1, Kunio Torii1
1Ajinomoto Co., Inc., Kawasaki, Kanagawa, Japan

Activation of medial frontal cortex (mFC) was observed during olfactory stimulation. In the present study, neural projections from olfactory cortices to the mFC were investigated in rats by manganese-enhanced MRI. Injection of Mn2+ into the olfactory bulb and lateral olfactory tract clearly enhanced T1-weighted signals in the primary olfactory cortex but not in the mFC. Signals in the mFC were enhanced by injection of Mn2+ into the amygdala, the mediodorsal hypothalamic nucleus and the hippocampal CA1. The results suggest that the mFC receives inputs from high-order olfactory centers but not from the olfactory bulb and the ventrolateral primary olfactory cortex.

13:34 1296. Tracing Neuronal Tract Between the Laminar Structures of Rat Olfactory Bulb Using Manganese Enhanced Magnetic Resonance Imaging
Ke Fang1, Ying Xia Li1, Fang Fang1, Hao Lei1
1The Chinese Academy of Sciences, WuHan, HuBei, People's Republic of China

The purpose of this study is to trace the neuronal tract between the laminar structures of rat olfactory bulb using manganese enhanced magnetic resonance imaging. T1-weighted inversion recovery MRI with high spatial resolution was used to observe the spatial pattern and the time course of Mn2+ transportation and accumulation in the rat olfactory bulb after intra-naris application of MnCl2 solution. The results reveal that the transportation of exogenous Mn2+ in the olfactory bulb is from the outer layers to the inner layers, and such process is relatively slow under non-stimulated condition.

Structural MRI Analyses of Neurologic Disorders

Swan Thursday 13:30 - 15:30

13:30 1297. Gray Matter Volume Changes in Idiopathic Generalised Epilepsy
Patrick C.H. Chan1, Regula Sofia Briellmann1, Gaby Simon Pell1, Anthony B. Waites1, Graeme David Jackson1
1Brain Research Institute, Heidelberg West, Victoria, Australia

Frontal lobe gray matter increase in idiopathic generalised epilepsy (IGE) has been reported, possibly indicating an underlying dysplastic abnormality. Using optimised voxel-based morphometry (VBM), we assessed 15 patients with refractory IGE and 95 healthy controls on a 3T GE scanner. The T1-weighted images were segmented, normalised, modulated and smoothed for SPM-based voxel-by-voxel comparison. At a corrected threshold of p<0.05, gray matter was decreased in the mesial occipital lobe and increased bilaterally in the basal ganglia, but not in the frontal lobe. Our results could be interpreted as a consequence of seizures rather than indicating causes of the epilepsy.
13:31 1298. Post-Surgical Failure after Temporal Lobectomy is Associated with Increased Medial Temporal Lobe Damage
Simon Keller1, Christine Denby1, Udo Wieshmann2, Neil Roberts1
1University of Liverpool, Liverpool, Merseyside, UK; 2The Walton Centre for Neurology and Neurosurgery, Liverpool, Merseyside, UK

Using voxel-based morphometry (VBM) on MR images, we report that temporal lobe epilepsy (TLE) patients in whom seizures persisted after surgery had significantly reduced grey matter in ipsilateral temporal lobe regions, predominantly hippocampus, posterior parahippocampal gyrus, amygdala, and entorhinal cortex relative to patients with successful post-surgical outcome on pre-surgical MRI. Furthermore, we observed volume reduction of the contralateral hippocampus in failures relative to successes. We suggest that ipsilateral temporal lobe damage posterior to the margins of resection and contralateral medial temporal lobe sclerosis may contribute to persistent post-surgical seizures.

13:32 1299. Combined Voxel-Based Analysis Of Volume and T2-Relaxometry in Temporal Lobe Epilepsy
Gaby Simon Pell1, Regula Sofia Briellmann1, Anthony B. Waites1, David Fenton Abbott1, Patrick CH Chan1, Graeme David Jackson1
1Brain Research Institute, Heidelberg West, Victoria, Australia

Hippocampal sclerosis (HS) is characterized by volume deficit, measurable by voxel-based-morphometry (VBM) and T2 change, measurable by voxel-based T2-relaxometry. Here we compare VBM and VBR analyses of 16 HS patients contrasted with 49 controls. Both methods identified ipsilaterial hippocampal changes, with VBR abnormalities greater in extent and significance. Conjunction analysis of VBM and VBR demonstrated abnormalities centralized to the head of the hippocampus. The ability to compare the two analyses in a common framework is novel, and will allow improved investigation of HS pathology.

13:33 1300. Voxel-Based Morphometry of Gray and White Matter in Lateralized Temporal Lobe Epilepsy
Alan B. McMillan1, Bruce P. Hermann1, Sterling C. Johnson1, Mary E. Meyerand1
1University of Wisconsin, Madison, Wisconsin, USA

Voxel-based morphometry was used to compare both gray and white matter volume in patients with lateralized temporal lobe epilepsy (TLE) versus healthy controls. TLE patients exhibited reduced gray matter volume in the ipsilateral hippocampus, ipsilateral thalamus, and cerebellum. Striking white matter volume reductions were found both ipsilateral and contralateral to side of seizure onset, the most prominent effect centered in the ipsilateral temporal pole. Profound and widespread white matter volume decreases suggest a perturbation of cerebral connectivity of which the neuropsychological consequences need to be investigated further.

13:34 1301. Amygdala Asymmetric Damage Increases with the Duration of Epilepsy
Pedro M. Gonçalves Pereira1, Eduardo Oliveira2, Mário F. Secca3
1University of Beira Interior, Covilha, Portugal; 2Health Science Institute (ISCS), Lisboa, Portugal; 3University Nova de Lisboa, Lisboa, Portugal

Several lines of evidence suggest that amygdala damage in temporal lobe epilepsy is asymmetrically bilateral. The factors underlying such asymmetries are relatively unexplored. This study correlates the asymmetry index of amygdala volumetry, relaxometry and ADC-mapping with the duration of epilepsy. Results show significant correlations between structural asymmetries and the duration of seizure disorder. Although these findings do not discard the possibility that a certain degree of unilateral damage can be present at the beginning of the disease, this cross-sectional multimodal MRI analysis of amygdala pathology agrees with our previous findings on the hippocampus, and suggests that asymmetrical damage is progressive.

13:35 1302. Phantom-Based Geometric Distortion Correction for Volumetric Imaging of Alzheimer's Disease
Richard P. Mallozzi1, Daniel J. Blezek1, Chadwick P. Ward2, Jeffrey L. Gunter2, Clifford R. Jack2
1General Electric Global Research, Schenectady, New York, USA; 2Mayo Clinic, Rochester, Minnesota, USA

A phantom-based calibration technique is presented to detect and correct geometric distortion for volumetric MRI of Alzheimer's Disease and other neurological disorders

13:36 1303. Segmentation Studies in Parkinsonism
Katja Krabbe1, Merete Karlshorg2, Andreas Hansen1, Lene Wedelh1, Henrik B.W. Larsson1, Olaf B. Paulson1
1Hvidovre Hospital, Hvidovre, Denmark; 2Bispebjerg Hospital, Copenhagen, Denmark

Whole brain segmentation and manual outlining of regions was used to study brain morphology in 10 patients with multiple system atrophy (MSA), 20 patients with Parkinson's disease (PD) and 18 matched controls. Volumes of putamina, substantia nigra and amygdala were significantly smaller in patients than in controls and caudate nuclei volumes were significantly smaller in MSA patients than in controls. Frontal lobe volumes did not differ between patients and controls. There were no significant differences in regional volumes between the two patient groups. The method proved useful in diagnosing parkinsonism, but failed to differentiate between PD and MSA.
Poster Sessions

13:37  **1304. Behavioral Deficits in Huntington’s Disease Correlate with Tissue Differences Measured with MRI.**
Fernando A. Barrios1, Leopoldo Gonzalez2, Rafael Favila2, Juan Fernandez2, Maria Alonso2
Perla M. Salgado2
1UNAM, Queretaro, QRO, Mexico; 2UNAM, Mexico, D.F., Mexico; lINNN-SSA, Mexico, D.F., Mexico

In this work, we present the resulting correlation between the Minimial Examination Test (MME), The University of Pennsylvania Smell Identification test (UPSIT) and Concurrent Visual Discrimination Test (CVDT), with non-biased 3D approach to estimate the statisticaly significant differences in tissue as measured in SPGR MRI between Huntington’s disease and age match healthy controls. Significant volume differences in brain tissue were localized in de caudate nucleus putamen and thalamus as well as an area in the inferior temporal lobe.

13:38  **1305. Increase of Brain Atrophy Rate in Patients with a Known Date of Onset of Alzheimer's Disease: A marker of Disease Progression.**
Yoshimi Endo1, Henry Rusinek2, Susan De Santi1, Dina Frid1, Wai-Hon Tsui1, Salomao Segal1
Antonio J. Convid1, Mony J. de Leon1
1New York University School of Medicine, New York, USA

Although many investigators have used MRI to show that the brains of patients with Alzheimer’s disease undergo atrophy, very little is known about how the atrophy rate changes with respect to length of disease. In this study involving coregistered MRI of 18 subjects with Alzheimer’s disease, we demonstrate that the rate of atrophy within the medial temporal lobe does not remain stable but increases approximately 0.5% per year for each additional year that the subject survives. This acceleration of volume loss further emphasizes the need for early intervention in patients with Alzheimer’s disease.

13:39  **1306. Spatial Distribution of T2, Values in the Hippocampus of Alzheimer’s Disease and Control Subjects.**
Daniel Bleeck1, John Schenck1, Zha Li1, Earl Zimmerman1, Tim O’Keeffe2
1GE Global Research Center, Niskayuna, New York, USA, 3Albany Medical College, Albany, New York, USA

Hypointense regions in T2 images of the brain are thought to indicate high iron concentration and may be linked to neurodegenerative diseases such as AD. Sensitivity to these regions is increased at 3T. 3T dual echo SE images have been acquired for Control volunteers (N=20) and probable AD patients (N=24). Hippocampus regions were hand segmented and deformed to a baseline hippocampus by: 1) rigid registration by the iterative closest point algorithm and 2) deformation using a thin plate spline. In the common reference frame, average T2 volumes are calculated and visually compared. We present the deformation methodology and qualitative results.

13:40  **1307. Assessment of Structural Differences in Healthy Elderly in Relation to Apolipoprotein E Polymorphism and a Comparison to Young Adults.**
Ira Driscoll1, Helen Petropoulos1, Robert J. Sutherland1, Ronald A. Yeo2, William M. Brooks3
1University of Lethbridge, Lethbridge, Alberta, Canada; 2The University of New Mexico, Albuquerque, New Mexico, USA; 3University of Kansas, Kansas City, Kansas, USA

Diffuse brain and hippocampal changes are the strongest identified anatomical features of AD. The e4 allele of the Apolipoprotein E (APOE) gene increases the risk of developing AD and lowers the age of onset. Associations of brain atrophy and APOE status in normal aging remain controversial. The present study aims to assess the relationship between whole brain and hippocampal volumes and APOE polymorphism in healthy elderly individuals, and compare them to young adults. Our findings suggest pronounced structural differences between the young and the elderly, while the differences between elderly e4 carriers and non-carriers are less pronounced.

13:41  **1308. Short-Term Effects of Typical and Atypical Antipsychotic Medication on Caudate Nucleus Volume in Drug-Naïve First-Episode Schizophrenia Patients.**
William Frans Christiaan Baaré1, Elbrich Jagersma2, Katrine Pagsberg3, Torben Mackeprang4
1Hvidovre Hospital, Hvidovre, Denmark; 2University of Groningen, Groningen, Netherlands; 3Bispebjerg Hospital, Copenhagen, Denmark

Caudate nucleus volumes were measured in twenty drug-naive patients with first-episode schizophrenia who were randomly allocated to treatment with the typical compound zuclopenthixol (N=8; mdd=10.3 mg) or the atypical compound risperidone (N=12; mdd 3.3 mg). Significant larger caudate volumes at follow-up were explained by a significant volume increase in the zuclopenthixol group while no volume change was observed in the risperidone group. Because the doses of risperidone administered in the present study are supposed to give approximately 65%-80% D2 receptor occupancy, equivalent to that of typical compounds, D2 receptor blockade alone is not sufficient to explain caudate nucleus enlargement.

13:42  **1309. Longitudinal Brain Volume Changes in Major Depressive Disorder.**
Philipp Sämann1, Elena Golgor2, Dorothee Praxedis Auer2
1Max-Planck-Institute of Psychiatry, Munich, Germany

Hippocampal volume loss, focal histological changes and abnormal cellular signalling in major depressive disorder suggest neurodegenerative or neurotoxic processes. To probe for acquired brain pathology, we performed longitudinal assessment (interval 39–93 months) of global brain volume changes in 19 subjects with MDD and no further major comorbidity. Postprocessing was done using the FSL/SIENA software. Annual rates of brain volume loss estimated from T2 (-0.55%) were comparable with T1 (-0.51%). This rate represents the upper range of reported rates for healthy subjects and is considerably smaller than in multiple sclerosis and Alzheimer’s disease ruling out a major global neurodegenerative process.
13:43  **1310. Abnormalities in Fronto-Parietal White Matter Microstructure May Be Associated with Increased Risk for Schizophrenia.**  
Vaiibhav A. Diwadkar1, John A. Sweeney2, Debra M. Montrose3, Matcheri Keshavan1  
1University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, USA; 2University of Illinois at Chicago, Chicago, Illinois, USA

The relationship between abnormalities in white matter microstructure and spatial working memory impairment was investigated in young individuals at risk for schizophrenia using voxel-based morphometry. Decreases in white matter concentration were more extensive in the high-risk sub-group showing impairment in working memory. Within the entire high-risk sample, decreases in fronto-parietal white matter concentration were correlated with increased impairment in spatial working memory. White matter abnormalities may be an important dimension of risk for schizophrenia suggesting that the illness may in part arise from neurodevelopmental disconnection. This disconnection may result in impaired performance on neurobehavioral tasks that rely on cortico-cortical collaboration.

13:44  **1311. Grey Matter Abnormalities Before the Onset of Psychosis: An Automated MR Image Analysis**  
Bridget Soulsby1, Paola Dazzan1, Xavier Chitnis2, Stephen J. Wood3, John Suckling4, Philip K. McGuire5, Patrick D. McGorry1, Robin M. Murray1, Dennis Velakoulis1, Lisa J. Phillips1, Alison R. Yung1, Christos Pantelis1  
1University of Melbourne, Melbourne, Victoria, Australia; 2Institute of Psychiatry, London, UK; 3University of Cambridge, Cambridge, UK

While structural neuroimaging studies have established that there are abnormalities in the brain structure of patients with schizophrenia in frontal and temporal regions it is still unclear at what stage of the illness that these abnormalities occur. Using an automated voxel based morphometry method which looks at differences in grey matter this study compares the differences between subjects who are at high-risk for the development of psychosis and normal controls. This will identify any grey matter abnormalities present before the transition to psychosis.

13:45  **1312. High Resolution MRI Neuromorphometric Assessment of the Amygdala in Mood Disorders**  
Allison Carol Nugent1, Rebecca Sills1, Earle Bain1, Linda Mah1, Dara Cannon, Alex Neumeister, Carlos Zarate, Sean Marrett1, Joel Price1, Alan Koretsky1, Latith Talagala1, Dennis Charney1, Wayne Curtis Drevets1  
1University of California, San Diego, La Jolla, CA, USA; 2Washington University, St. Louis, Missouri, USA; 3University of Cambridge, Cambridge, UK

Neuromorphometric MRI studies have produced conflicting results in the measurement of amygdala volume in mood disorders. This study used manual segmentation of high resolution (0.6x0.6x0.6mm) MRI images to measure the amygdala volume in healthy subjects and subjects with bipolar or unipolar depressive disorder. A significant reduction in the amygdala bilaterally was found for the unipolar subjects as compared to either bipolar subjects or healthy controls.

13:46  **1313. MRI Findings in Neuropsychiatric Lupus**  
Stefan C.A. Steens1, Wiljan J.N. Ouwendijk1, Gerda M. Steup-Beekman1, Gerlof P. Th. Bosma1,  
Tom W.J. Huizinga1, Mark A. van Buchem1  
1Leiden University Medical Center, Leiden, Netherlands

Aim of this study was to assess the range of abnormalities in 166 brain MRI scans of 49 systemic lupus erythematosus (SLE) patients with neuropsychiatric (NP) syndromes according to recently developed case definitions. In 65% of patients one or more abnormalities were found. Apart from white matter hyperintensities (±2/3 of patients), we observed a high incidence of gray matter lesions (±1/3 of cases) that has not been reported before. Our findings suggest cortical gray matter damage as an important etiologic factor in NPSLE.

13:47  **1314. Longitudinal Study of Brain Atrophy and Lesions in HIV-Infected Patients**  
Pippa Storey1, Joel Meyer1, Bruce Cohen4, Leon Epstein1, Ann B. Ragin1  
1Evanston Northwestern Healthcare, Evanston, Illinois, USA; 2Northwestern University, Chicago, Illinois, USA

Two sets of MRI scans were performed at an interval of approximately one year in eight HIV-infected patients and seven control subjects. The images were reviewed by a clinical neuroradiologist, and analyzed quantitatively for the volumes of brain parenchyma and CSF. Significant reductions in the percentage of brain parenchymal volume (PBV) were found in the HIV patients relative to the controls at both time points, and PBV measures were significantly correlated with clinical markers of neurocognitive impairment. The rate of atrophic change across the one-year time period however did not differ significantly between the groups.

13:48  **1315. Dilated Perivascular Spaces: A Hallmark of Traumatic Injury**  
Robert I. Grossman1, Matilde Inglese1, Oded Gonen1, Lois Mannon1, Benjamin Cohen1, Henry Rusinek1  
1New York University School of Medicine, New York, New York, USA

The frequency of dilated perivascular or Virchow-Robin spaces (VRS) was evaluated in 24 patients with traumatic brain injury (TBI) and in 17 age- and gender-matched controls. The number of VRS in apical white matter was 7.1+/-4.6 in TBI and 2.4+/-2.9 in control subjects (p<0.0003). Dilated VRS were not correlated with the time after injury. Striking enlargement of VRS in brain trauma appears to be a new neuroradiologic marker of the injury. Since the dilatation is independent on the time since injury, it probably reflects early and permanent brain change, most likely caused by the presence of inflammatory macrophages or microglia.
13:52  1318. Volumes of Anatomically Defined Brain Structures on MR Images Increase With Continued Abstinence From Alcohol

Stefan Gazdzinski1, Timothy Craig Durazzo1, Colin Studholme2, Emmi Song3, Dieter Johannes Meyerhoff4
1VA Medical Center, San Francisco, California, USA; 2University of California, San Francisco, California, USA

In recovering alcoholics, we used automated methods (probabilistic segmentation combined with automated atlas-based region labeling of major lobes, cerebellum, brainstem, and subcortical structures, boundary shift integral and surgical navigation technology) to assess whole brain and regional brain tissue volume changes over 1-6 months of abstinence as well as functional changes. White matter volume recovery in alcoholics was faster in the first month of sobriety than in the following months, whereas gray matter volume was recovering at a similar rate across time intervals, suggesting earlier recovery of white than gray matter.

13:53  1320. A Generalized Method for Detecting Therapy-Induced Leukoencephalopathy

John O. Glass1, Ching-Hon Pui1, Wilburn E. Reddick2
1St. Jude Children's Res Hosp, Memphis, Tennessee, USA

The evolution of late radiation-induced injury of the temporal lobes in 27 patients was studied on serial MRI spanning 2.1-5.7 years with 3-7 MRI examinations performed. Of 50 temporal lobes with lesions, 10 remained static, 14 improved progressively, 12 deteriorated progressively, 14 waxed and waned. Increase in the extent of blood-brain barrier disruption and increase in deposition of blood breakdown products but not cystic changes were significantly associated with deterioration. Deterioration associated with increase in blood breakdown products alone occurred at a significantly later interval compared to those associated with increase in extent of blood-brain barrier disruption alone.

13:54  1321. Multiple Contrast Mechanisms in Synthetic Images Calculated From a Single IR TrueFISP Experiment

Vikas Gulani1, Peter Schmitt1, Mark A. Griswold1, Peter M. Jakob2, Markus Kotas3, Michael Flentje1, Axel Haase4
1Universität Würzburg, Würzburg, Germany; 2Experimentelle Physik 5, Würzburg, Germany

We propose a procedure to obtain multiple synthetic MR images with T1-weighted, T2-weighted, Spin density-weighted CSF-nulled FLAIR contrast using data obtained from a single experiment. This is accomplished by calculating T1, T2 and spin density maps from a single IR TrueFISP scan. The synthetic images with these different contrasts essentially reveal the contrast behavior and diagnostic information of the corresponding 'real' MR images acquired with spin echo or turbo spin echo sequences. Thus, it is possible to get images with multiple types of contrast from a single MRI measurement, improving efficiency and eliminating misregistration of anatomical structures between the images.
13:55  **I322. Study of Sulcal and Anatomical Landmarks Variability in the Inferior Frontal Lobe**

Ivan Zimine1, Heike Juch1, Jean H D Fasel2, Karl O. Lovblad2, Francois Lazeyras3

1Geneva University Hospitals, Geneva, Switzerland; 2Geneva University, Geneva, Switzerland

Using 3D-MRI and publicly available software for sulci identification (Anatomist), the current study aimed at investigation of anatomical variability of the main sulci in the inferior lobe. Assessment of this variability is important for the identification of language area found by fMRI.

13:56  **I323. Structural Abnormalities in Cluster-Headache, A VBM Study**

Nicole Schmitz1, Mark Kruit1, Guus Schoonman1, Michel Ferrari1, Mark van Buchem1

1LUMC, Leiden, Netherlands

Synopsis Cluster headache (CH) shows no abnormalities on conventional MRI scans. However, the condition is characterised by unilateral headaches accompanied by autonomous and neurological symptoms, presenting as severely disabling for the sufferer. The current study identifies grey and white matter abnormalities in CH individuals compared to control subjects. We found specific anatomical patterns according to headache side.

13:57  **I324. High Resolution Anatomic and Physiological Imaging of the Optic Nerve and Optic Chiasm at 3T**

Elena Vinogradov1, David B. Hackney1, Derek R. Smith1, Robert Marquis1, Robert E. Lenkinski1

1Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA

Many patients with multiple sclerosis exhibit optic neuritis as their first symptoms. We have begun a comprehensive program aimed at imaging the optic nerve and optic chiasm at 3T. A custom designed head coil containing an array of four square coils was used to acquire images. The S/N of this coil allows acquisition of high resolution anatomic images with the slice thickness of 1.5mm and in-plane resolution of 352x469 µ2. These images may provide clear visualization of the optic nerve and the optic chiasm. Also, preliminary results of high spatial resolution 3D-MT experiments at 3T are presented.

13:58  **I325. Absence of Major Gray Matter Volume Changes in Obstructive Sleep Apnea**

Regula Sofia Briellmann1, Fergal O'Donoghue1, Patrick C.H. Chan1, Gaby Simon Pell1, Peter Rochford1, Robert Pierce1, Graeme Daniel Jackson1

1Brain Research Institute, Heidelberg West, Victoria, Australia; 2Institute for Breathing and Sleep, Heidelberg, Victoria, Australia

Obstructive sleep apnea (OSA) is a sleep disorder, associated with neuropsychological deficits. Here we investigate grey matter volume changes in a homogenous group of 17 patients with severe OSA, using VBM and manual morphometry before and after six-month treatment. In contrast to an earlier publication on this topic, no major deficits were detected in severe OSA, and no treatment effect was present. In particular, there was no hippocampal volume deficit, confirmed with both analysis approaches. This suggests that grey matter deficits are not a prominent cause or consequence of this disease.

13:59  **I326. Voxel Based Morphometry in Patients with Albinism**

Bernd Schmitz1, Georg Groen1, Torsten Nils Schaefer2, Christoph Maria Krick3, Barbara Kaesmann-Kellner1

1University Hospitals Ulm, Ulm, Germany; 2Saarland University Hospitals, Homburg, Germany

Purpose of the present study was to explore morphological changes of the brain in patients with albinism. MPRAGE sequences were acquired in 17 patients with albinism and 15 normal controls and evaluated using voxel based morphometry. Patients with albinism showed a bilaterally symmetric reduction in gray matter density in various cortical and subcortical areas but not in primary visual areas. These may reflect adaptive changes to abnormalities of the visual system, but may also be caused by the genetic abnormality. Histologically known changes of the primary visual cortex remarkably do not correlate with reduction of gray matter density in these areas.

14:00  **I327. Increased Intracranial Volume in Normal Pressure Hydrocephalus: Evidence for Benign External Hydrocephalus as the Etiology**

William G. Bradley1, Francis Safar2

1UCSD, San Diego, California, USA

Intracranial volumes were measured in patients with clinical NPH and increased aqueductal CSF stroke volumes and age and sex-matched controls. The NPH patients had significantly larger volumes. This suggests that the initial insult in NPH occurs in infancy while the sutures can still expand, eg, as a result of benign external hydrocephalus. Thus it appears that NPH results from two insults: the first in infancy and the second in old age as a result of deep white matter ischemia. Thus patients with “slightly enlarged ventricles” should be watched for early signs of a gait disturbance as they become older.

14:01  **I328. Structural Abnormalities in Migraine, A VBM Study**

Nicole Schmitz1, Mark Kruit1, Guus Schoonman1, Faiza Admiraal-Behloul1, Michel Ferrari1, Mark van Buchem1

1LUMC, Leiden, Netherlands

Migraine is a common neurovascular disorder characterized by recurrent attacks of severe headache, autonomic nervous system dysfunction, and in up-to one-third neurological aura symptoms. The patho-physiology of Migraine is unclear, however, we found significant anatomical differences in grey and white matter volume that might be an underlying cause for the disorder.
14:02  **1329. A Modified Fuzzy Clustering Method for Modelling Partial Volume Effects in MRI Data**

Jon McAusland¹, Erick Wong², Andrew Riddehough¹, David K. B. Li¹

¹University of British Columbia, Vancouver, British Columbia, Canada

Partial Volume Fuzzy Clustering Method (PVFCM) is proposed as a variant of standard Fuzzy Clustering Method (FCM) to find class centres associated with tissue types present in MR image files. Such files are normally dominated by voxels representing more than one tissue type, and this tends to degrade the results calculated with FCM. In PVFCM partial volume effects between pairs of classes are modelled, allowing the original "pure classes" to more accurately represent the target tissue types. The resulting method enjoys the rapid convergence of FCM while providing nearly a factor of two improvement over FCM in finding class centres.

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**Functional MRI Measures of Neurologic Disorders**

Swan  Monday 14:00 - 16:00

14:00  **1330. Correlation Between T2-Relaxometry and Proton MRS Abnormalities in Different Epilepsy Syndromes**

Regula Sofia Briellmann¹, R. Mark Wellard¹, Gaby S. Pell¹, Anthony B. Waites¹, Graeme D. Jackson¹

¹Brain Research Institute, Heidelberg West, Victoria, Australia

We assessed T2-relaxometry and Proton MRS in 23 patients with lesional temporal lobe epilepsy (TLE), 8 patients with MR negative TLE and 9 patients with idiopathic generalized epilepsy (IGE). Lesional TLE showed the expected temporal changes, and frontal lobe NAA and creatine reduction. Hippocampal T2 T2 increase correlated with temporal lobe myoinositol increase, suggesting an association with gliosis in the seizure focus. MR-negative TLE showed subtle hippocampal T2 increase, which correlated with reduced frontal lobe NAA, consistent with a consequence of the epilepsy. IGE patients had no T2 relaxation time changes, but frontal lobe MRS abnormalities, consistent with widespread metabolic disturbance.

14:01  **1331. Myelination in First-Episode Psychosis Patients Measured by Myelin Water Imaging**

Donna J. Lang¹, Heather M. Emmerton¹, Cornelia Laule¹, G William MacEwan¹, Alex L. MacKay¹, William G. Honer¹

¹University of British Columbia, Vancouver, British Columbia, Canada

Patients with psychosis and schizophrenia-related psychosis suffer from a combination of motor, cognitive and affective deficits. In the current pilot study, first-episode, minimally treated patients and age-matched controls underwent myelin water imaging to assess regional myelin water fraction (MWF). Significant decreases in patient MWF’s were observed in frontal white matter (WM) (left genu, right/left minor forceps), medial WM (right anterior internal capsule), and in posterior WM (right/left splenium, right/left major forceps) compared to controls. Significant correlations between MWF and age, and MWF and years of education, were found for various white matter regions in controls, but not in patients.

14:02  **1332. Diffusion Tensor Imaging Of Children With Early Onset Of Schizophrenia**

Manzar Ashtari¹, Sanjiv Kumra², Babak Ardekani³, Tana Clarke¹, David Becker², David Roofeh², John Kane², Philip Szeszko²

¹North Shore Long Island Jewish Health System, New Hyde Park, New York, USA; ²Zucker Hillside Hospital, Glen Oaks, New York, USA; ³Nathan S. Kline Institute for Psychiatric Research, Rockland, New York, USA

Sophisticated voxel based analysis is used to study patients with early onset of schizophrenia (EOS) and normal controls. Patient had lower FAs in the gnu of corpus callosum, bilateral Heshel’s, parahippocampal, MT gyri and the left STG. These areas are frequently reported in functional and morphometric literature of adult schizophrenia. A recent voxelwise study of adult chronic schizophrenia patients reported similar. Our findings are also consistent with the results of a recent postmortem study in patients with chronic schizophrenia that have implicated a cluster of genes involved in the formation and maintenance of myelin sheaths.

14:03  **1333. 1H Magnetic Resonance Spectroscopy of Human Schizophrenia Brain: A Replication Study**

Kent Harris¹, Alma Ghari¹, Pratip Bhattacharya², Alexander Peter Lin², Brian David Ross²

¹HMRI, Pasadena, California, USA; ²Rudi-Schulte Research Institute, Pasadena, California, USA

Despite evidence of neurochemical abnormalities in Schizophrenia(SZ), defined by 1H, 31P, and decoupled 31P MRS, published literature is contradictory both on the metabolic detail and the regional brain distribution. Prior to dynamic 13C MRS exploration of SZ with undertook regional 1H MRS to xxx the current confusion. Despite almost universal agreement that Naa/Cr is reduced in SZ, we found no significant changes in the eight brain regions assayed. We did confirm our earlier finding that SZ have modest increases in Cho/Cr. These data permit a more sophisticated hypothesis to be applied in further 13C MRS studies of SZ brain.
To assess the clinical feasibility of semi-automatic ROI using diffusion tensor tractography (DTT) in patients with amyotrophic lateral sclerosis (ALS). 16 patients with ALS (9 limb-onset & 7 bulbar-onset) and 9 volunteers were studied. DTT of corticospinal tracts and corticobulbar tracts (CBT) were visualized.

14:05 1335  Diffusion Tensor Markers for Amyotrophic Lateral Sclerosis

Amittrajit Gogoi1, Samir Misra2, Ivan Mihailidis2, Mark Mandelkern2, Albert Wu2, Qian Gao2, Chun He3, Shigeki Aoki4, Junya Uekusa4, Hiroshi Mitsumoto5
1University of California, San Diego, La Jolla, California, USA; 2University of Kentucky, Lexington, Kentucky, USA; 3Shiga University of Medical Science, Otsu, Shiga, Japan; 4University of Tokyo, Bunkyo-ku, Tokyo, Japan; 5University of Bonn, Bonn, Germany

DTI has the potential to uncover structural changes in brain tissues of patients with idiopathic Parkinson disease. After evaluating the feasibility of DTI at 3T in healthy controls, we compared ADC- and FA-values of 12 patients and 11 controls. We found significant differences in the substantia nigra and basal ganglia. Additional MRS relaxometry, which should theoretically be more accurate at 3T than at lower field strengths, showed a trend towards shorter T2 relaxation times in basal ganglia of patients reflecting the expected higher iron content.

14:06 1336  Diffusion Tensor Imaging and MRS Relaxometry at 3T in Patients with Idiopathic Parkinson Disease

Carsten Krautmacher1, Frank Träber1, Petra Mürtz1, Omid Kakade2, Okan Gürmüz3, Wolfgang Block4, Tanja Schmitz-Hübsch1, Ulrich Wüllner5, Hans H. Schild6
1University of Bonn, Bonn, Germany; 2Weill Medical College of Cornell University, New York, USA; 3Columbia University, New York, USA; 4University of Tokyo, Bunkyo-ku, Tokyo, Japan; 5University of California, Irvine, Irvine, California, USA; 6University of Bonn, Bonn, Germany

To investigate whether there are significant changes in regional brain metabolism in patients with Parkinson’s disease after thalamotomy using proton magnetic resonance spectroscopy (1H MRS). NAA/Cr (or, NAA/Cho) ratios showed generally normal levels in the primary motor cortex (M1) and supplementary motor area (SMA) in Parkinson’s disease patients with clinical improvement following thalamotomy. Our results suggest that NAA/Cr (or, NAA/Cho) ratios may not be a valuable criterion for evaluation of Parkinson’s disease patients with the clinical improvement following surgery.
Pre-mortem diagnosis of PRION diseases is sometimes difficult using standard clinical criteria and spinal fluid testing. Four patients with autopsy-proven Creutzfeldt-Jakob disease were studied ante mortem using standard MRI protocols supplemented by perfusion and high b-value (b=2500) diffusion sequences. Gyril signal abnormalities were more conspicuous and extensive at high b-values compared to routine DWI (b=1000). Cortical regions showing the greatest DWI signal changes also showed prolonged perfusion mean transit times. High b-value DWI and perfusion measurement may improve sensitivity for detection of PRION diseases in the clinical evaluation of patients with rapidly progressive dementia.

A combination of Diffusion Tensor Imaging (DTI) and Spectroscopy provide complementary information aiding understanding of disease pathology. We applied this to Adrenomyeloneuropathy (AMN), genetic neurological disease. Results showed low N-Acetylaspartate (NAA) with no choline elevation, indicating structural defect or dysfunction in a structurally intact neuron. DTI showed low fractional anisotropy indicating neuronal tract damage, arguably from loss of axonal or myelin integrity. Also, diffusion parameters correlate with NAA/Creatine and NAA/Choline ratios. Lowering of NAA and FA, in the absence of choline changes, and correlation of two lowered parameters suggests structural axonal damage in the absence of active demyelination.

Early detection of demyelination in ALD is crucial for clinical intervention. MRS and DTI have shown highly sensitive for early detection of white matter damage in ALD. High b value DWI using q-space analysis, MRS and DTI were applied in two pre-symptomatic and three symptomatic ALD patients. The three methods were able to detect abnormal signal in hyper intense T2 lesions and in some areas of the NAWM. However, high b value DWI detected extended damaged area than DTI. This method may provide a tool for follow up of normal white matter development in pre-symptomatic young ALD subjects.

This study has used a model for magnetization transfer to estimate two underlying parameters (the macromolecular proton fraction (f) and the macromolecular T2 (T2b)), in patients with multiple sclerosis (MS). Global normal-appearing white and gray matter (NAWM and NAGM) measures were derived from f and T2b maps in 58 MS patients and 27 healthy controls. f detected abnormality in NAWM, NAGM and lesions while T2b was only reduced in lesions. A negative correlation was seen between f and T2b in NAWM and NAGM. The methodology could be detecting a difference in pathological mechanisms in lesions as compared to NAWM.

Optic neuritis is an ideal model for the study of relapse in multiple sclerosis as there are reliable measures of optic nerve function using clinical assessment, conduction using Visual Evoked Potentials (VEP), and structure using MRI. We present two year data from a prospective study of acute unilateral optic neuritis using these measures. We show that optic nerve atrophy and reduced MTR persist at two years following an attack of optic neuritis and correlate with visual acuity, visual field mean deviation, and contrast sensitivity. Optic nerve area, but not MTR, correlates with VEP amplitude and latency.

Liver cirrhosis is also accompanied by impaired mental abilities in patients. Relaxometry revealed changes in relaxation times in the basal ganglia due to liver disease. Manganese is probably responsible for T1 and T2 shortening. After liver transplantation, a gradual recovery to normal values was observed using MR relaxometry within 2 years. MR relaxometry revealed a moderate T2 decrease in the basal ganglia 5-8 years after transplantation, possibly caused by the aging of the subjects.
14:16 **1346. Lower Absolute CBF in Heavy Drinkers and Compensatory Blood Flow Changes in Treated HIV+ Heavy Drinkers**

Dieter Johannes Meyerhoff1, Frank Ezekiel, Norbert Schaff1, Joseph Kniecik2, Colin Studholme1, Michael W. Weiner1
1University of California San Francisco, DVA Medical Center, San Francisco, California, USA; 2University of California San Francisco, San Francisco, California, USA

We performed multislice pulsed arterial spin-labeled perfusion MRI in lightly and heavily drinking HIV+ patients on stable antiretroviral medication. Perfusion data sets were co-registered with tissue segmented 3D MR images, on which the major lobes were identified using atlas-based non-linear transformations. We found hyperperfusion in gray matter and white matter throughout the brain of chronic heavy drinkers that was associated with measures of ataxia. Absolute CBF was also lower in frontal gray matter of HIV+ patients on stable antiretroviral medication, suggesting ongoing brain injury despite “effective” antiretroviral therapy.

14:17 **1347. Proton MR Spectroscopic Changes in Primary Motor Cortex and Supplementary Motor Area of Hemiparetic Patients**

Hyun-Man Baik1, Bo-Young Choi1, Jeong-Seok Kim1, Seong-ik Yun1, Jeong-Woo Lee1, Tae-Seok Suh1, Hyeong-Ku Lee1
1MRI Laboratory, Seoocho-Ku, Seoul, Republic of Korea

To determine the primary motor cortex (M-1) and supplementary motor area (SMA) dysfunction on affected and unaffected hemisphere, authors performed proton magnetic resonance spectroscopy (1H MRS) for the evaluation of biochemical changes in the motor cortex in hemiparesis according to axonal injury at the level of internal capsule. We found that the mean N-acetylaspartate (NAA)/ phosphocreatine (Cr) and NAA/ choline (Cho) ratios were significantly decreased in M-1 on affected hemisphere of hemiparesis patients.

14:18 **1348. Susceptibility Weighted Imaging of Brain Masses**

Zach Delproposto1, Vivek Sehgal1, E. Mark Haacke1, Djamel Haddar2, Andrew E. Sloan1, Lucia J. Zamorano1, William J. Kupsky1, Yingbiao Xu1, Karthik Prabhakaran1, Ilaya R. Elangovan1, Juergen R. Reichenbach1, Karen Tong1
1Wayne State University, Detroit, Michigan, USA; 2MRI Institute for Biomedical Research, Detroit, Michigan, USA; 3Friedrich-Schiller University, Jena, Germany; 4Loma Linda University, Loma Linda, California, USA

High grade tumors are usually characterized by a rapidly growing vasculature and numerous internal microhemorrhages. To detect their presence is important in gauging the tumor grade at an early stage. We show that susceptibility weighted imaging often provides better contrast when imaging intracranial tumors than conventional methods by enhancing venous vasculature and microhemorrhages.

14:19 **1349. Diffusion Tensor Imaging and Fiber Tracking in Delineating the Degeneration of Motor and Sensory Pathways in Periventricular Leukomalacia**

Bejoy Thomas1, Maria Eyssen1, Paul Van Hecke1, Stefan Sunaert1
1University Hospitals KUL, Leuven, Belgium

Periventricular Leukomalacia (PVL) is a major neuropathologic form of brain injury encountered in survivors of premature birth. Diffusion Tensor Imaging (DTI) and Fiber Tracking open a new and robust way to evaluate the white matter pathways in this clinical condition. 5 cerebral palsy patients of known PVL were studied using DTI. There was significant reduction in the number of fibers in the corticospinal tract on the affected side on all 4 hemiparetic patients, in addition to involvement of posterior thalamic radiation in 3 of them. Bilateral involvement was noted in the quadripletic patient.

14:20 **1350. Diffusion Tensor MRI after Pediatric Brain Injury**

Khader M. Hasan1, Bhavik P. Kanabar2, Rafeal M. Santos1, Mary Prasad1, Larry A. Kramer1, Linda Ewing-Cobbs1, Ponnada A. Narayana1
1University of Texas, Houston, Texas, USA; 2UH, Houston, Texas, USA

Whole brain diffusion tensor and conventional MRI were performed on 4 traumatically brain injured (TBI) and 7 control children for visualization and quantification of pathology. Fractional anisotropy (FA) values of seven functionally distinct regions within the corpus callosum (CC) were estimated. The extent of injury to the CC was more clearly visible on the FA maps compared to conventional MRI. FA values were significantly reduced in anterior and posterior regions of the CC in the TBI children compared to controls. Our study shows that DT-MRI is promising in characterizing and localizing TBI in school-age children.

14:21 **1351. 1H MR Spectroscopy of Mild Form of Canavan Disease: Role of NAA in Neuron-Oligodendrocyte Interaction**

Goran Vucurevic1, Georg Kutscher2, Joachim Gawehn1, Karena Thieme1, Peter Stoeter1
1Institute for Neuroradiology Mainz, Mainz, Germany; 2Children Hospital University of Mainz, Mainz, Germany; 3Max Planck Institute for Polymer Research, Mainz, Germany

Canavan disease (CD) is commonly considered as a spongiform leukodystrophy caused by lack of function of aspartoacylase, enzyme found in oligodendrocytes, responsible for hydrolysis of N-acetyl-aspartate. We present the case of CD which is not followed by dismyelination, but presented with milder neurological symptoms. Spectroscopy findings show pattern common to the “standard” CD in grey matter (lack of cholines, increased myo-inositol) and different in the white matter (“normal” choline values). This “residual form” of CD helps in understanding of the role of NAA in brain function and supports the role of NAA as a brain osmolyte.
Phase-contrast MRI was used to measure the amplitude and timing of CSF pulsations in the brain. As compared to earlier studies utilizing peak systolic and diastolic positions to measure CSF flow timing, we used custom data processing and fitting to extract accurate flow timing parameters. In a group of healthy individuals, these measurements clearly show that CSF flow in the cerebral aqueduct lags behind flow in the cranial and spinal subarachnoid spaces, as well as the arterial flow in the cranium. A statistically significant lag of flow in the preoptic plexus was also found.

A susceptibility sensitive sequence was applied to volunteers to investigate the response of venous blood vessels in the human brain to breathing oxygen or carbogen. Phase information was used to directly visualize changing magnetic field distributions around venous vessels. Compared to air, phase contrast of venous vessels decreased during oxygen and carbogen breathing, while contrast between tissues of different iron content was left unchanged. Cross sectional views of veins and the surrounding parenchyma display the changing field distribution with changing oxygenation. The results may be valuable to predict the effects of radiosensitization of tumors with carbogen.

Idiopathic intracranial hypertension (IIH) is a disorder associated with intracranial pressure greater than 250mm water, normal neuroimaging and cerebral spinal fluid content. Our objective was to investigate the effect of increased intracranial pressure in IIH on brain perfusion and white matter integrity by diffusion tensor imaging (DTI), q-Space analysis of high-b-value diffusion weighted imaging (high-b-DWI) and perfusion weighted imaging (PWI). We found correlation between abnormal rCBV and decreased q-space probability values. This result suggests that IIH maybe radiologically characterized by PWI and high-b-DWI thus the conventional definition of IIH (normal neuroimaging) might be misleading.

We assessed gray matter loss using voxel based morphometry, and functional abnormalities using BOLD signal changes to Valsalva maneuvers, in heart failure (HF) patients and controls, and found a close correspondence of regions showing reduced volume and diminished or phase-altered functional responses. Other areas also showed functional deficits, likely resulting from altered input from regions of gray matter loss. Isolated sites showed accentuated BOLD signal change in regions of no gray matter loss, and may represent compensatory responses. Gray matter loss in HF is associated with impaired BOLD signal changes, and may contribute to deficient autonomic responses and poor outcome.

Dynamic susceptibility contrast MR imaging (DSC-MRI) provides a sensitive tool for evaluating cerebral blood volume and flow that are critical in maintaining the brain function and metabolism. Although multiple sclerosis (MS) is a demyelinating disease with the most lesions are found in the white matter, gray matter involvement has also been observed with significant neuronal loss and neurodegenerative changes. This study was to assess the extent of basal ganglionic gray matter (thalamus and putamen) neurodegeneration in patients with relapsing-remitting MS and compared with control subjects using BOLD signal changes and may represent compensatory responses. Gray matter loss in HF is associated with impaired BOLD signal changes, and may contribute to deficient autonomic responses and poor outcome.

Dynamic susceptibility contrast MR imaging (DSC-MRI) provides a sensitive tool for evaluating cerebral blood volume and flow that are critical in maintaining the brain function and metabolism. Although multiple sclerosis (MS) is a demyelinating disease with the most lesions are found in the white matter, gray matter involvement has also been observed with significant neuronal loss and neurodegenerative changes. This study was to assess the extent of basal ganglionic gray matter (thalamus and putamen) neurodegeneration in patients with relapsing-remitting MS and compared with control subjects using the absolute method of DSC-MRI.

To improve the accuracy of tissue structural characterization with diffusion tensor imaging, a novel anisotropic smoothing technique for image noise reduction is developed. Built upon the concept of diffusion filtering, this technique smoothes images along the direction of smaller intensity gradients preferentially to that of larger gradients. This smoothing anisotropy is particularly useful for denoising diffusion tensor images in which direction information of structures needs to be restored from noise corruption and preserved around tissue boundaries. The effectiveness of this smoothing technique is demonstrated by experiments with a computer phantom and in vivo human data.
In addition to providing noninvasive and quantitative measurements of tissue perfusion, ASL methods can also image the perfusion distribution of individual arteries through selective labeling. Such information may be useful in assessing collateral flow patterns. While this has been most commonly implemented using a separate labeling coil, this approach requires the use of customized hardware with uncertainties in labeling efficiency. Here we describe a simple approach for selectively determining hemispheric cerebral blood flow with a modified PASL sequence.

A major limitation in arterial spin labelling (ASL) perfusion MRI is the poor signal-to-noise ratio (SNR) in the perfusion-weighted images. The relatively low perfusion values observed in white matter result in increased sensitivity to noise in these regions, resulting in measurements of perfusion that are generally unreliable. In this study, independent component analysis techniques were applied as a denoising method to ASL datasets collected in healthy volunteers. The removal of the noise components by this means significantly improved the SNR of the perfusion-weighted images, and enabled greatly improved perfusion measurements to be made in white matter regions.

Background suppression can greatly reduce motion and other sources of noise in Arterial Spin Labeling MRI. More sophisticated background suppression strategies with many inversion pulses may decrease the ASL signal causing reduced SNR and quantitative accuracy. Numerical simulations and in-vivo measurements were used to measure the inefficiency of different adiabatic inversion pulses and to optimize pulse selection. The results emphasize the high potential efficiency of adiabatic inversion pulses but also the limited optimal range of pulse parameters.

A decoupling circuit for three-RF-Coil ASL MRI experiments was designed and evaluated in vitro and in vivo. The experimental results show this circuit to be effective and simple to implement.

A continuous arterial spin labeling (ASL) technique with amplitude modulated control was implemented using a single coil at 3.0T. Comparable adiabatic inversion efficiency was achieved at 3.0T as compared with 1.5T by appropriately reducing the amplitude of RF pulses and gradient strength. The amplitude modulated control provided a good match of the magnetization transfer effect of the labeling pulses, rendering the capability for multi-slice perfusion imaging that covers the whole brain. Comparison of multi-slice continuous and pulsed ASL methods at 3.0T showed a 33% improvement in the signal-to-noise ratio (SNR) by using the former approach.
13:36  **1364. Optimization of the Labeling Time for Continuous Arterial Spin Labeling MRI**

Kai-Hsiang Chuang1, Scott Chesnick1, Alan P. Koretsky1, S Lalith Talagala1

1National Institutes of Health, Bethesda, Maryland, USA

The SNR per unit time in arterial spin labeling MRI can be optimized through the labeling time but this has not been experimentally verified in human brain. We systematically changed the labeling time to evaluate the optimal values for perfusion quantification and functional studies. Results showed that SNR per unit time followed the expected trend and temporal SNR increased with the labeling time. Since the t statistics of task activation increased with number of repetition, the labeling time can be optimized for specific task design.

13:37  **1365. Impact of Model Choice on Quantitative Perfusion Measurements using Continuous Arterial Spin Label Imaging**

Greg Zaharchuk1, Alastair J. Martin2, David Saloner1, William P. Dillon1

1University of California at San Francisco, San Francisco, California, USA; 2Philips Medical Systems, Best, Netherlands

Previous ASL studies have used a variety of different post-processing models to convert ASL difference images into quantitative perfusion maps. This study processed the same continuous ASL raw data in 16 volunteers using 4 previously published models to determine whether the choice of model affected calculated perfusion levels. Significantly different perfusion levels were identified based solely on model choice. Therefore, if clinical decisions are to be made based on absolute perfusion thresholds, attention to the model used to convert raw ASL data into quantitative perfusion images is necessary. Possible reasons for the discrepancies between models are discussed.

13:38  **1366. Spin Labeling Perfusion MRI with Simultaneous Transit Time Measurement**

Peter van Gelderen1, Jacco A. de Zwart1, Jeff H. Duyn1

1National Institutes of Health, Bethesda, Maryland, USA

A multi-slice fast spin tagging perfusion method is presented, which has a higher temporal resolution than standard methods. The method can simultaneously measure perfusion and transit time effects, as well as remaining MT effects. The overall repetition time was reduced by shifting the label pulse into the preceding acquisition; the transit time and MT information was obtained by using a m-sequence to switch the label. The method is resulted in perfusion SNR of 50-100 in a 10min scan at 3T, at 2.3x2.3x3.5mm3 resolution.

13:39  **1367. CBF Changes During Brain Activation: fMRI vs. PET**

Ching-Mei Feng1, Shalini Narayana1, Jack L. Lancaster1, Paul A. Jerabek1, Tom L. Arnow1, Li Hai Tan1, Peter T. Fox1, Jia-Hong T. Gao1

1University of Texas Health Science Center at San Antonio, San Antonio, Texas, USA; 2University of Hong Kong, Hong Kong, People's Republic of China

The changes in regional cerebral blood flow (rCBF) associated with the changes in neuronal activity are measured both by positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) techniques. However, direct comparison has not been performed to determine similarities and differences of PET and fMRI. In the present study, a quantitative comparison of the functional rCBF maps obtained by PET and fMRI are made. By selecting the conjunctive pixels activated on both PET and fMRI maps, the changes in rCBF measured by fMRI was 36.95 ± 2.54 % while by PET was 38.79 ± 2.63 %.

13:40  **1368. Modeling the ASL Signal Under Dynamically Changing Perfusion and Arterial Transit Time: Considerations for Event Related FMRI**

Luis Hernandez-Garcia1, Gregory Ryan Lee1, Douglas Noll1

1University of Michigan, Ann Arbor, Michigan, USA

In the present work, we explore the sensitivity of the arterial spin labeling perfusion signal to the dynamic changes in perfusion and transit time observed during a period of neuronal activation. We present a numerical approach to modeling the activation that captures the non-linearity of the ASL measurement during dynamic changes and apply this framework to the FAIR, CASL as well as the turbo-CASL approaches.


Wen-Ming Luh1

1National Institutes of Health, Bethesda, Maryland, USA

Absolute perfusion values derived from arterial spin labeling techniques was compared with gray matter volume fraction maps to estimate the perfusion quantity of pure gray matter in human brain. The gray matter volume fraction was estimated from double inversion recovery images.
The Effect of the Apparent Transverse Relaxation Time on Cerebral Blood Flow Values Obtained at 1.5 and 4.0 Tesla
Keith St. Lawrence¹, Jiongjiong Wang²
¹Lawson Health Research Institute, London, Ontario, Canada; ²University of Pennsylvania, Philadelphia, Pennsylvania, USA

Since a significant fraction of the arterial spin tagging signal originates from capillaries, the observed cerebral blood flow can be affected by differences in T2* values between tissue and blood. CBF was measured as a function of echo time at 1.5 and 4.0 T, and as predicted by a model that included a capillary compartment, the CBF measurements at 4.0 T decreased with echo time due to the reduction in blood T2*.

Perfusion Tensor Imaging
Lawrence R. Frank¹, Eric C. Wong¹
¹UC San Diego, La Jolla, California, USA

Velocity selective ASL (VS-ASL) is an alternative to standard ASL methods that employ spatial tagging schemes because of its insensitivity to transit delays and T1 decay. Here we point out that another advantage is that it facilitates the acquisition of direction dependent perfusion measurements, thereby allowing a more complete investigation of the local inflow field. We introduce the technique of perfusion tensor imaging (PTI), in which we collect multi-angle perfusion measurements, from which we then derive the mean perfusion, the perfusion anisotropy, and the principal direction of perfusion. This is demonstrated on a normal human volunteer.

Effect of Magnetization Transfer on Quantification of CBF
Tae Kim¹, Seong-Gi Kim²
¹University of Minnesota, Minneapolis, Minnesota, USA; ²University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Quantification of CBF using arterial spin labeling (ASL) methods assumes that labeled water in blood diffuses freely into tissue and exchanges with macromolecular protons. To test out whether this assumption is valid at all ASL measurements, we measured CBF with different MT effects with and without suppression of the blood signal contribution. With suppression of blood, the calculated CBF values are independent of MT effects. Therefore, the dependence of calculated CBF values with MT effect is due to saturation of the tissue pool, but not in the blood pool.

Arterial Blood Volume and Blood Volume Changes Measured using ASL in Humans
Caroline Hoad¹, Susan Francis¹, Penelope Gowland¹
¹University of Nottingham, Nottingham, UK

The multislice EPISTAR technique has been used in humans to non-invasively measure arterial blood volume and the change in arterial blood volume on activation. Arterial blood volume (as a fraction of total voxel water) was estimated to be ~0.4% and the change in arterial blood volume on activation was estimated to be ~50%.

Improving the Quantification of Continuous ASL: Simulations of the Adiabatic Inversion Efficiency using Phase Contrast Velocity Measurements
Ruth L. O’Gorman¹, David J. Lythgoe², Paul E. Summers², David C. Alsop², Steven CR Williams², Fernando E. Zelaya²
¹King's College Hospital, London, UK; ²Institute of Psychiatry, London, UK; ³University Hospital of Zurich, Zurich, Switzerland; ⁴Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

We have demonstrated a strategy to quantify the velocity-dependent inversion efficiency of continuous ASL using phase contrast velocity measurements and simulations of the Bloch equations. Perfusion images were acquired for 8 subjects using a multislice continuous ASL technique. Cardiac-gated axial phase contrast MRA images were acquired at the level of the tagging plane and the Bloch equations were solved numerically using the measured spin velocity profiles. The calculated inversion efficiencies ranged from 69%-70%, which increased the CASL whole-brain perfusion measurements by an average of 4%.

Analysis of Flow Dispersion as a Source of Systematic Error in Quantitative Arterial Spin Labeling
Y. Mazaheri¹, T. T. Liu¹, E. C. Wong¹, P. Moses³, R. B. Buxton¹
¹UCSD, La Jolla, California, USA

The goal of this work was to investigate flow dispersion as a source of systematic error in perfusion imaging with arterial spin labeling. Two alternative flow models that account for distribution of flow velocities were compared to the commonly used plug flow model. ASL data were fitted to the arterial kinetic model using all three flow models. The measured dispersion of blood flow velocities can provide information regarding brain microvasculature. It is also a source of systematic error in quantitative ASL measurements.

A Perfusion Phantom for the Validation of Arterial Spin Labeling Measurements
Alexander Kroll¹, Frank Risse¹, André Bongers¹, Lothar R. Schad¹
¹Deutsches Krebsforschungszentrum, Heidelberg, Germany

Arterial spin labeling (ASL) is used to determine local tissue perfusion without applying contrast agents. The ASL-signal reflects the relative perfusion. A general kinetic model provides a theory to determine absolute perfusion using ASL. In this work a phantom is presented, which is able to validate this model by perfusing a highly porous polymer with an accurately defined amount of perfusate. The absolute perfusion measured by ASL is in good agreement with the absolute perfusion in the polymer.
**13:49 1377. Perfusion Imaging with FAIR Turboprop**

Atsushi M. Takahashi¹, Eric T. Han¹, Jean Brittain¹, James G. Pipe²

¹GE Medical Systems, Menlo Park, California, USA; ²Barrow Neurological Institute, Phoenix, Arizona, USA

FAIR has been combined with the Turboprop pulse sequence for improved off-resonance and patient motion correction.

**13:50 1378. Background Suppressed 3D Perfusion Measurement using Arterial Spin Labeling and Single-Shot 3D-GRASE**

Matthias Guenther¹, Koichi Oshio¹, David A. Feinberg¹

¹Advanced MRI Technologies, Sebastopol, California, USA

Arterial spin labeling (ASL) produces perfusion-weighted images without the use of contrast agents by acquiring two data sets with different preparations, where the signal difference is very small. Background suppression (BS) techniques can be used to optimize the receiver gain setting to the labeled blood signal. We implemented a single-shot 3D-GRASE sequence with optional BS for arbitrary inflow times. Comparisons between perfusion-weighted images with BS and without BS show ~10% higher signal-to-noise ratio (SNR) with BS. ASL with background suppressed single-shot 3D-GRASE readout yields high SNR perfusion-weighted images in less than a minute.

## Diffusion and Perfusion: Methodology and Applications

**Swan**

Thursday 13:30 - 15:30


Michael Richard Smith¹, Richard Frayne¹

¹University of Calgary, Calgary, Alberta, Canada

Long-standing reports of cerebral blood flow (CBF) estimates varying with arterial tissue delay (ATD) have recently been shown to be an implementation artifact of singular value decomposition (SVD) deconvolution algorithms. Now both SVD and Fourier-transform (FT) deconvolution algorithms produce equivalent, under-estimated, CBF values. Adaptive techniques have been suggested to compensate this underestimation. However the use of adaptive SVD (or FT) deconvolution algorithms uncovers a previously unrecognized variation of CBF with ATD. This is not another correctable algorithmic implementation artifact, but a direct consequence of experimental CBF protocols not accurately representing (sampling) the rapid changes in the tissue contrast signals.

**13:31 1380. Improved Perfusion Imaging of the Human Brain using Dynamic T₁-Weighted Contrast Enhanced MRI at 3 Tesla.**

Henrik BW Larsson¹, Thomas Keil¹, Torgil R. Vangberg², Anders Kristoffersen², Per Arvid Steen², Joern Kvaernes³, Olav Haraldseth¹

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The aim was to see if quantification of perfusion in the human brain is improved using T1-weighted MRI with the high SNR of 3 tesla. Five volunteers were subjected to dynamic contrast enhanced imaging with a 3D turbo-FLASH sequence and a bolus injection of gadodiamide. The input function from the arteries had a very high SNR and both gray and white matter showed distinct tissue enhancement. The perfusion was quantified by direct deconvolution of the tissue curve with the input function, resulting in estimated mean perfusion in gray matter of 90 ml/100g/min and in white matter of 10 ml/100g/min.

**13:32 1381. A Correlation Method of MR Contrast Perfusion Quantification Based on SVD Deconvolution**

Sumiko Abe¹, Akihiko Shinoda²

¹GE Yokogawa Medical Systems, Hino, Tokyo, Japan; ²Shiga Medical University, Ohtsu, Shiga Prefecture, Japan

In quantifying cerebral perfusion with dynamic magnetic resonance contrast perfusion weighted image (MR-PWI), we proposed to detect the filter parameter voxel-by-voxel for SVD deconvolution. MR-PWI CBF was compared with PET CBF as the gold standard on the same subject. The results show that the new method has a higher significance correlation with PET CBF mapping.

**13:33 1382. Reference Based Quantification Method of Perfusion without using Arterial Input Function in Dynamic Susceptibility Contrast MRI : Clinical Assessment with Pulsed Arterial Spin Labeling**

Kiyohiko Takahashi¹, Tokunori Kimura¹, Isao Naito¹, Takeshi Nozokido¹, Takaaki Sato¹, Shin Takatama¹

¹Geriatrics Research Institute and Hospital, Maebashi, Gunma, Japan; ²Toshiba Medical Systems, Otawara, Tochigi, Japan

The purpose of this study is to assess reference based quantification methods that are robust to measurements of arterial input functions (AIF) in DSC-MRI. Difference of appearance time (deltaAT) and the ratio of maximum gradient of tissue curve between contralateral regions instead of CBF were assessed for cerebral clinical data. Pulsed arterial spin labeling (PASL) was used for correlation study. The CBV ratio calculated with the area under curve and the CBF ratio calculated with the maximum gradient method for tissue curve indicated clinical usefulness especially in stroke patients because of its simplicity and robustness to the AIF dependent errors.
Perfusion Quantification by Bolus-Tracking: An Alternative Solution to the Problem of Tracer Arrival Timing

Steven Sourbron¹, Rob Luypaert¹, Peter Van Schuerbeek¹, Martine Dujardin³, Michel Ostéaux¹
¹Vrije Universiteit Brussel, Brussels, Belgium

CBF quantification with DSC-MRI is sensitive to delays between the AIF and the tissue concentrations. Recently a circulant embedding of the problem was proposed as a solution. We show that such a method, apart from doubling the size of the computational problem, is restricted by the requirement that the tissue concentrations vanish at the end of the measurement. We propose and validate an alternative approach which generalizes the tracer kinetic model to the case where causality is violated. In a practical implementation this is equivalent to enforcing positive delays by artificially shifting the AIF towards earlier times before post-processing.

Reduction of Contrast Recirculation Effects in DSC MR CBF Quantification Using Frequency-Domain Modeling

Jean Jing Chen¹, Michael Richard Smith¹, Richard Frayne¹
¹University of Calgary, Calgary, Alberta, Canada

The accurate assessment of cerebral perfusion is invaluable in the prognosis and treatment of cerebrovascular diseases. Dynamic susceptibility (DSC) MR imaging is a powerful tool for noninvasive perfusion measurement, where the cerebral blood flow (CBF) is calculated through deconvolution. However, standard deconvolution algorithms exhibit artifacts caused by noise suppression and contrast recirculation, leading to CBF estimation errors. Deconvolution by frequency-domain modelling has the potential to correct noise-related errors, as demonstrated through the frequency-domain Lorentzian modelling (FDLM) approach. Simulations and patient studies further suggest the FDLM technique to be less sensitive than standard methods to contrast recirculation.

Local Arterial Input Function for Perfusion MRI Calculated Using Independent Component Analysis

Fernando Calamante¹, Morten Moerup³, Lars Kai Hansen²
¹Institute of Child Health, London, UK; ²Technical University of Copenhagen, Copenhagen, Denmark

A new methodology to calculate a local arterial input function (AIF) using independent component analysis is described, and tested on data from patients with various cerebrovascular abnormalities. The methodology is compared to the conventional approach of using a global AIF (measured in a major artery). The new methodology produced higher perfusion values (compared to the global AIF case) in areas with distorted AIF's, suggesting that the effect of bolus delay/dispersion is minimized. The minimization of these effects should lead to a more accurate quantification of perfusion, which can have important implications for diagnosis and management of patients with cerebral ischemia.

High Resolution Gd-DTPA Bolus Tracking at 3T

Peter van Gelderen¹, Susan O'Flahavan¹, Bobby K. Lewis¹, Joseph A. Frank¹, Jeff H. Duyn¹
¹National Institutes of Health, Bethesda, Maryland, USA

To reduce partial volume effects in bolus tracking high resolution MRI is necessary, while measurement of low blood volume areas in white matter requires a high voxel SNR and large bolus effects. These requirements can be met using a efficient 16-channel receiver at 3T with SENSE imaging. Results from 1.5mm resolution data show that with a standard clinical dose the rCBV can be estimated with 2% accuracy in grey-, and 5% in white matter, while time to peak can be estimated to 100ms and 250ms respectively. This brings bolus tracking in the range of standard clinical imaging resolution.

Feasibility and Limitations of Independent Component Analysis in the Investigation of Blood-Brain-Barrier Permeability

Wen-Chau Wu¹, Yi-Jui Liu², Cheng-Yu Chen³, Hsiao-Wen Chung⁴
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Independent component analysis (ICA) uses high-order signal statistics to separate sources blindly. However, interpretation and validation of the extracted components are not always easy. In this abstract, we used ICA to explore dynamic signals obtained by first-pass dynamic T2*-weighted contrast-enhanced MRI and attempted to depict areas with blood-brain-barrier (BBB) breakdown. Brain glioma and ischemic stroke subjects were analyzed. Discrepancies were found and potential limitations were addressed by computer simulation. Results showed that with prudent explication, ICA could be an efficient method to screen pixels of BBB breakdown in stroke followed by further evaluation.

Automatic Arterial Input Function Measurement for Perfusion MRI

Song Lai², John P. Lackey¹, Yuan-Yu Hsu², Ho-Ling Anthony Liu²
¹Thomas Jefferson University, Philadelphia, Pennsylvania, USA; ²Chang Gung University, Taoyuan, Taiwan

A robust algorithm was developed to automatically identify an optimal cluster of pixels for the measurement of arterial input function in dynamic susceptibility contrast agent-based perfusion MRI. Based on tracer kinetics, we proposed that the optimal cluster of pixels for AIF would have the following characteristics: 1) high cerebral blood volume; 2) high peak of R2 change as a ramification of high contrast agent concentration; 3) early time-to-peak. Results on both normal subjects and clinical patients demonstrated that the proposed computerized algorithm could reliably identify an optimal cluster of pixels adjacent to the middle cerebral artery for measurement of AIF.
This work describes a novel local arterial input function method and examines its effect on cerebral blood flow maps (CBF) as compared with using a single global arterial input function. It is shown that the resulting local CBF maps have the largest differences in regions of low flow when compared with the global CBF. When these regions are mapped back to the brain, in many patients they are found in the hemisphere ipsilateral to the lesion, leading to the conclusion that the localized AIFs are reducing effects caused by delay with respect to the global AIF.

**13:41 1390. First Pass Bolus-Tracking Measurement of Transendothelial Water Exchange in Healthy Controls**

*William Roomey*, *Xin Li*, *Frank Telg*¹, *Maria Taylor*, *Patricia Coyle*, *Charles Springer, Jr.*²

¹Brookhaven National Laboratory, Upton, New York, USA; ²Oregon Health and Science University, Portland, Oregon, USA; ³USB, Stony Brook, New York, USA

Measurements of $^3$H$_2$O R$_1$, $\Delta$[ident]/1/T1 during contrast reagent (CR) first-pass were obtained to investigate brain vascular properties in healthy controls at 4 T. A markedly non-linear relationship between blood and brain tissue R$_1$ values was found, indicating that transendothelial water exchange departs the fast exchange limit in clinically relevant blood CR levels. For centrum semiovale white matter, a mean fractional blood volume of 1.4% (±0.2%) and an intravascular water lifetime of 0.26 s (±0.03 s) was obtained.

**13:42 1391. Can Multiparametric MRI-Based Predictive Algorithms Assess Efficacy of Thrombolysis in Hyperacute Stroke Patients?**

*Ona Wu*, *Soren Christensen*, *Niels Hjort*, *Pedro Rosa-Neto*, *Kim Mouridsen*, *Anders Rodell*, *Rick M. Dijkhuizen*, *Jens Fiehler*, *Joachim Röther*, *Leif Østergaard*

¹University Medical Center Utrecht, Utrecht, Netherlands; ²Århus University Hospital, Århus, Denmark; ³University Hospital Hamburg-Eppendorf, Hamburg, Germany

A multiparametric algorithm for predicting infarction in hyperacute stroke patients was trained on the conservative-treatment arm (Group 1) (n=12) of a trial of thrombolytic therapy. The calculated parameters were then applied to the treatment arm (Group 2) (n=29) to investigate whether predictive algorithms can assess therapeutic effects. The accuracy of models in Group 2 was less than that of Group 1 (p<.05). Furthermore, correlation between predicted infarct and measured infarct was less in Group 2 (R=.57) than Group 1 (R=.90). These results indicate that multiparametric MRI-based algorithms can be used to objectively evaluate the efficacy of treatment strategies.

**13:43 1392. Anatomy as a Parameter in Multiparametric MRI-Based Predictive Algorithms**

*Ona Wu*, *Soren Christensen*, *Pedro Rosa-Neto*, *Niels Hjort*, *Anders Rodell*, *Rick M. Dijkhuizen*, *Jens Fiehler*, *Joachim Röther*, *Leif Østergaard*

¹University Medical Center Utrecht, Utrecht, Netherlands; ²Århus University Hospital, Århus, Denmark; ³University Hospital Hamburg-Eppendorf, Hamburg, Germany

Anatomical information was incorporated into multiparametric MRI-based algorithms combining DWI and PWI for predicting infarct in hyperacute human stroke (< 6h) and compared to models without anatomic weighting. Both models were trained using the con-servative-treatment arm (n=12) of a trial of thrombolytic therapy. The accuracy of the anatomically-weighted GLM was superior to the non-weighted GLM (p<.05). Because of the increased accuracy and negligible computational overhead, anatomically-weighted GLM is preferable over standard GLM for clinical stroke diagnosis and prognosis.

**13:44 1393. Dynamic Changes in Blood-Brain-Barrier Permeability after Transient Focal Cerebral Ischemia in Rats**

*Chien-Yuan Lin*, *Hsiao-Wen Chen*, *Yu-Yin Tung*, *Tai-Mei Cheung*, *Teng-Nan Lin*, *Chen Chang*

¹Academia Sinica, Taipei, Taiwan

The association of CBF and CBV with angiogenesis after transient focal cerebral ischemia has been documented. However, the relationship between the changes in cerebral hemodynamics and disruption of blood-brain barrier (BBB) permeability, which is a possible mechanism causing reperfusion injury, is unknown. In the present study, dynamic contrast-enhanced MRI (DCE-MRI) was applied to investigate the temporal changes of BBB permeability, Ktrans, in rats subjected to 60 mins of middle cerebral artery occlusion (MCAO).

**13:45 1394. Comparison of Arterial Transit Delays and Bolus Widths in Children and Adults as Measured with Arterial Spin Labeling**

*Pamela Moses*, *Yousef Mazaehri*, *Thomas T. Liu*, *Leigh N. Sepeta*, *Eric C. Wong*, *Richard B. Buxton*, *Joan Stiles*

¹University of California, San Diego, California, USA

Arterial spin labeling (ASL) imaging provides a noninvasive means of studying cerebral blood flow in healthy children. ASL techniques rely on physiological parameters that may change with brain maturation. To determine appropriate parameters for children 8 and 12 years of age, this study estimated arterial transit time and arterial bolus width by fitting ASL data to a theoretical model. Comparisons between children and adults suggest a trend in shorter transit times, at rest and during activation, for 8-year-olds relative to adults. Transit times in 12-year-old children did not differ significantly from adults', nor did the bolus widths for either group.
Moyamoya syndrome (MMS) is an angiographically defined cerebrovascular disorder with terminal internal carotid artery occlusion and basal collateral vessels. Surgical revascularization (SR) is a potential treatment, but the indications for, and efficacy of, this intervention are controversial. Quantification of perfusion MRI using summary parameters (e.g. time-to-peak (TTP)) has been shown to be useful for the identification of hemodynamic abnormalities in MMS, and it may, therefore, also play an important role in the evaluation of treatment outcome. In this study we investigate the use of histograms created from TTP maps to evaluate the hemodynamic effects of SR in children with MMS.

Evaluation of the Hemodynamic Effects of Surgical Revascularization in Pediatric Moyamoya Syndrome using Perfusion MRI

Fernando Calamante1, Vijaya Ganesan1, Martin David King1, David Geoffrey Gadian1, Alan Connelly1
1Institute of Child Health, London, UK

The goal was to characterize age-related changes in kinetics of human brain perfusion with pulsed ASL MRI. A parameter for exchange time of blood flowing into the capillary bed was added to a kinetic model of perfusion to account for an increase in vascular resistance with age. Dynamic ASL perfusion studies on 11 volunteers showed an increase in exchange time with age (r=0.71, p<0.02), while blood flow decreased with age, although not significant (r =-0.25, p >0.1). Exchange time may be a sensitive marker for changes in cerebral microvascular plasticity that may accompany Alzheimer’s disease and vascular dementia.

Age-Related Changes in Kinetics of Brain Perfusion Measured by Pulsed ASL MRI

Norbert Schuff1, Geon Ho Jahng1, Xioping Zhu1, Ka-loh Li, Michael W. Weiner1
1DVA Medical Center & UCSF, San Francisco, California, USA

A four-year study of elderly subjects is being conducted at the University of Pittsburgh to identify markers for Alzheimer’s disease (AD) dementia. Preliminary results are being generated from the first year (2002-2003) of the study. Blood flow velocities, perfusion rates, and T1 relaxation were measured using phase contrast (PC) Cine, multislice continuous arterial spin labeling (CASL), and saturation recovery MRI, respectively, for patients diagnosed as normal (N=9), mild cognitive impaired (MCI) (N=9), and early dementia (N=6). Among the groups, dementia subjects had the lowest gray matter perfusion, while MCI had the lowest gray and white matter T1s.

Flow and Perfusion in the Evolution of Dementia: Preliminary Findings

H. Michael Gach1, Weiying Dai1, Venkata Lakavaram1, James T. Becker1, Oscar Luis Lopez1
1University of Pittsburgh, Pittsburgh, Pennsylvania, USA

We use MR method to investigate the correlation between NAA concentration (as a neuron marker) when reperfusion commenced and the maximum degree of BBB disruption that was indicated with post contrast T1 enhancement at chronic stage with luxury reperfusion. Our data demonstrated that surviving neuron number at the time when reperfusion occurring after ischemia may be an affecting factor for the reperfusion to be beneficial or harmful.

Spontaneous Reperfusion after Stroke, Beneficial Or Harmful? A Study with Proton MR Spectroscopy and Gadolinium Enhancement on T, WI

Chang-Shin Lee1, Cheng-Yu Chen1, Chaoying Wang1
1Tri-Service General Hospital, Taipei, Taiwan

Preoperative Differentiation of Intracranial Dural Metastases and Meningioma Using Quantitative Diffusion MR Imaging

J HM Chan1, E YK Tsui1, P P. Jt1, L F. Chau1, D Fong1, M K. Yuan1, K PC Wong1, K KL Fung1
1Hong Kong Polytechnic University, Hung Hum, Hong Kong; 2Tuen Mun Hospital, N.T., Hong Kong; 3Kwong Wah Hospital, Kowloon, Hong Kong; 4North District Hospital, Sheung Shui, Hong Kong

Cerebral metastases may occasionally present as a focal meningeal mass, mimicking meningioma. The aim of this study was to evaluate the feasibility of using apparent diffusion coefficients (ADCs) and diffusion anisotropy indices (DAI) in discriminating dural metastases from meningiomas. The mean ADC and DAI values were found to be (0.812 ± 0.178) x 10^-3 mm² s⁻¹ and 0.235 ± 0.078 in meningiomas, and (1.788 ± 0.252) x 10^-3 mm² s⁻¹ and 0.083 ± 0.016 in dural metastases respectively. Our preliminary results indicate that combined utilization of apparent diffusion coefficients and diffusion anisotropy indices may be able to provide reliable differentiation between dural metastases and meningiomas.

DWI Identifies Thalamic and Hippocampal Involvement in Patients with Prolonged Ictal Activity

Kristina Szabo1, Amnathur Poepel2, Bernd Pohlmann-Eden4, Jochen Hirsch4, Tobias Back4, Oliver Sedlacek1, Michael Hennerici1, Achim Gass1
1Universitätsklinikum Mannheim, Mannheim, Germany; 2University of Bonn, Bonn, Germany; 3Epilepsy Center, Bethel, Germany; 4Universitätsklinikum Kantonsspital, Basel, Switzerland; 5Universitätssklinik, Marburg, Germany

DWI can detect early changes related to ictal activity. We report DWI in 16 patients with acute clinical deficits due to prolonged focal ictal activity. We identified different patterns of acute DWI changes: Hyperintensity limited to the hippocampus was found in five, hyperintensity limited to cortical areas adjacent to the pathology in two patients. In the other nine, DWI alterations were either in the hippocampus and thalamus (5), in the hippocampus, thalamus and cortex (1) or in the cortex and thalamus (3). This provides further evidence for the involvement of mesial temporal lobe and dorsomedial thalamic structures in epilepsy.
13:52 1401. White Matter Abnormalities in Schizophrenia Studied by High b Value Diffusion Imaging

Talma Hendler1, Maya Blaich1, Avi Mendelsohn1, Pazit Pianka1, Yoram Cohen1, Raz Even1, Hagai Harari1, Rael D. Strous1, Yaniv Assaf1
1Tel Aviv Sourasky Medical Center, Tel Aviv, Israel; 2Tel Aviv University, Tel Aviv, Israel; 3Shalvata Mental Health Center, Hod Hasharon, Israel; 4Beer Yaakov Mental Health Center, Tel Aviv, Israel

Accumulating evidence is pointing to disturbed neural connectivity as a major source of brain abnormality in schizophrenia. High b value q-space analyzed diffusion imaging was used to characterize white matter pathophysiology in schizophrenia patients. We found both gray and white matter abnormality in the dorso-lateral prefrontal cortex and the temporal cortex. We also found that the number of pixel having normal white matter signal (at least in the q-space probability images) is markedly reduced revealing significant damage in white matter. We suggest that white matter damage is a significant and measurable pathological brain marker in schizophrenia.

13:53 1402. Regional Variations of Apparent Diffusion Coefficient in the Brain: Correlation with Glasgow Coma Score Among Traumatic Brain Injury Patients

Rao P. Gullapalli1, Karthikamanthan Shannuganathan1, Steven Roys1, Prasad Murthy1, Stuart Mirvis1
1University of Maryland, Baltimore, Baltimore, Maryland, USA

Prompted by our previous findings on strong correlation with whole brain ADC histograms to the Glasgow Coma Scale (GCS) we performed a retrospective study on 44 patients following traumatic brain injury. Specifically we correlated ADC histograms of the whole brain, and various regions of the brain with GCS to see if certain regions of the brain were more affected than others. The ADC’s for both the whole brain and other regions of brain showed significant correlation with GCS. Both individual regions and the whole brain showed significant correlation with GCS indicating a general disruption of water mobility throughout the brain.

13:54 1403. Lack of Incidental DWI Hyperintense Lesions in Healthy Elderly Individuals

Kristina Szabó1, Hansjörg Büzner1, Christian Blahak1, Michael Hennerici1, Achim Gass1
1Universitätsklinikum Mannheim, Mannheim, Germany

The high prevalence of T2 lesions in the elderly is well known and their presence is regarded non-specific, their clinical value is uncertain. We investigated the prevalence of small hyperintense incidental DWI lesions in 72 healthy elderly controls. The controls showed subcortical T2 lesions of grades 1-3 according to the Fazekas scale, but no incidental DWI hyperintense lesions were identified. On the basis of these results the occurrence of hyperintense lesions on DWI appears to be a more specific finding indicating acute pathology.


Akira Nakatani1, Beni Shiomi1, Shuntaro Oka1, Miki Karami1, Kenichi Kashikura2, Tomohisa Okada2, Shinji Takamatsu2, Yasuhisa Fujibayashi3, Yasushi Arano4
1Nihon Medi-Physics Co. Ltd., Sodegaura, Chiba, Japan; 2Fukui Medical University, Yoshida, Fukui, Japan; 3Chiba University, Inage, Chiba, Japan

The local cerebral blood flow (LCBF) by H217O MRI has not been proved that it gives appropriate LCBF compared to other methods. In this study, the comparison of LCBF between H217O MRI and H215O PET was performed in dogs with the blood circulation hemodynamics being carefully controlled. In result, the LCBF by H217O MRI was almost equivalent to the one by H215O PET, and showed good linearity to the PaCO2 change, i.e. from lower to higher CBF range. This suggests that H217O MRI using widespread MRI equipments could be an alternative of H215O PET, which is highly specialized equipment.

13:56 1405. Effect of Tracer Delay on CBF Determination by DSC-MRI: Comparison with Positrion Emission Tomography

Masanobu Ibaraki1, Eku Shimosegawa1, Hideto Toyoshima1, Keiichi Ishigame1, Kazuhiro Takahashi1, Syuichi Miura1, Hiroshi Ito1, Iwao Kanno1
1Nihon Medi-Physics Co. Ltd., Sodegaura, Chiba, Japan; 2Tohoku University, Sendai, Miyagi, Japan

The purpose of the study was to assess the effect of tracer delay on CBF determination by SVD deconvolution in DSC-MRI. In the perfusion study for 7 healthy men, we compared CBF by DSC-MRI (MRI-CBF) with that by positron emission tomography (PET-CBF). The results demonstrate that the differences between MRI-CBF and PET-CBF are partly ascribed to the tracer delay correction will enable us to estimate more accurate CBF with less inter-subject variability.

13:57 1406. Do High Molarity Contrast Agents Improve Cerebral Perfusion Imaging at 3T?

Oliver Thilmann1, Elna-Marie Larsson2, Isabella Maria Björkman-Burtscher2, Freddy Ståhlberg1, Ronnie Wirestam1
1Lund University, Lund, Sweden; 2Lund University Hospital, Lund, Sweden

Aim: To evaluate and compare three different combinations of contrast agents and doses for possible advantages of high-molarity agents and to assess the optimal agent and dose in dynamic susceptibility contrast MRI at 3T. Methods: 16 healthy volunteers received 0.1 mmol/kg bodyweight Gadovist (Schering, 1.0 mmol/ml), 0.1 mmol/kg bw Multihance (Bracco, 0.5 mmol/ml) and 0.2 mmol/kg bw Gadovist in three separate examinations. Results: In a ROI-analysis double dose Gadovist showed significantly higher relative signal decrease and concentration-to-noise level than both single dose examinations. However bolus quality, grey/white matter ratio, grey-white matter contrast and diagnostic suitability were evaluated equal for all three doses.

Ashok Kumar¹, Christopher J. Wiggins¹, Caterina Mainero¹, Weiting T. Zhang¹, Graham C. Wiggins¹, Bruce Fisch⁴, A. J.W. Kouwe¹, R. Pienaar¹, C. Triantafyllou¹, A. Potthast¹, Lawrence L. Wald¹, Alma Gregory Sorensen¹

¹Massachusetts General Hospital, Boston, Massachusetts, USA

Dura mater is the major pain-sensitive intracranial structure and is implicated in the generation of headaches. In conventional MRI, the visualization of dura is problematic due to low SNR and due to its relative thinness compared to the adjacent cortical structures and the imaging voxel size. We used 3T and 7T high field MRI to successfully distinguish the supratentorial dura mater from leptomeninges and cortical gray matter. At 7T a relatively high CNR of 14.4 was obtained for dura versus the subdural meninges. Ability to perform a sufficiently complete morphometry of dura is likely to be of significant clinical value.

13:59 1408. **Microcirculation in Pituitary Dwarfism: Time to Peak Analysis by Contrast-Enhanced Dynamic MR Imaging**

Chao-Ying Wang¹, Chang-Shin Lee¹, Cheng-Yu Chen¹, Hsiao-Wen Chung²

¹Tri-Service General Hospital, Taipei, Taiwan; ²National Taiwan University, Taipei, Taiwan

The pituitary gland is a complex neuroendocrine organ involved in the control of a variety of homeostatic mechanisms. Subtleties in the internal anatomy of this gland such as specializations in its regional microcirculation are now becoming appreciated. Pituitary dwarfism may lead to vasculature changes of the gland that may cause a microcirculation deficiency. To investigate the changes in the pituitary microcirculation in dwarfism patients, we performed dynamic MR imaging to measure the delayed contrast enhancement in patients. The perfusion deficiency was also evaluated spatially to correlate with the growth hormone deficiency.

**Pediatric Brain Injury: Diffusion and Perfusion**

Swan  Monday 14:00 - 16:00

14:00 1409. **ADC Values in the Posterior Limb of Internal Capsule are Predictive of Outcome Following Perinatal Asphyxia**

Rod W. Hunt¹, Michael J. Keen², Jeffrey J. Neill³, Lee T. Coleman², Terrie E. Inder²

¹Royal Children's Hospital, Parkville, Victoria, Australia; ²Royal Children's Hospital, Melbourne, Victoria, Australia; ³St Louis Children's Hospital, St Louis, Missouri, USA

MR diffusion weighted imaging currently provides the most sensitive early marker of cerebral injury following perinatal asphyxia. Qualitative abnormalities of the posterior limb of the internal capsule have previously correlated with poor clinical outcome. We studied ADC values in the PLIC to determine if they were predictive of clinical outcome and found that they correlated with neurodevelopmental outcome at 12 months of age. We propose that they may be of use as a prognostic marker for infants with hypoxic ischaemic encephalopathy.

14:01 1410. **Single-Shot Fast Spin-Echo Diffusion MR Imaging of the Brainstem and Cerebellum in Premature Newborns**

Duan Xu¹, Pratik Mukherjee¹, Steven P. Miller¹, Srinivasa Veeraghaven¹, Hua Jin¹, Ying Lu¹, Roland G. Henry³, Donna M. Ferraro¹, A James Barkovich¹, Daniel B. Vigneron¹

¹University of California, San Francisco, California, USA

In this study, we applied a single-shot fast spin-echo (SSFSE) sequence to investigate DTI parameters in the brainstem and cerebellum of premature neonates which had not previously been reported. EPI-DTI suffers from spatial distortions especially near the air-tissue interfaces of the posterior fossa. The spatial distortions in DTI-SSFSE are negligible, thus allowing quantitative assessments of water diffusion in the brainstem and cerebellum. In this study we demonstrated the feasibility of obtaining SSFSE-DTI in these regions and reported normative Dav values. Significant differences were observed between regions and with gestational ages in agreement with known maturational changes of the prematurity brain.

14:02 1411. **Alterations in Water Diffusion Anisotropy Indicate Widespread Cerebral White Matter Injury in Premature Infants**

Hong Xin Wang⁴, Masa Pavlović⁴, Deanne Thompson⁴, Simon K. Warfield⁴, Jeff Neil⁴, Poh Seng Ong⁴, Gary F. Egan⁴, Terrie E. Inder⁴

¹University of Melbourne, Melbourne, Victoria, Australia; ²Brigham & Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; ³Washington University, St. Louis, Missouri, USA; ⁴Royal Children's and Royal Women's Hospital, Melbourne, Victoria, Australia

Diffusion tensor images of the brain were acquired for 110 infants (19 term and 91 preterm) using line scan protocol. Apparent diffusion coefficient and relative anisotropy were calculated. Results: In the preterm group, ADC values are significantly higher (p<0.001) and RA values are significantly lower (p<0.005) than those in the full term. The infants with white matter injury have the highest ADC values and the lowest RA values. ADC values are the lowest in the motor area. Conclusion: This study provides objective evidence of widespread white matter abnormality in this group of infants.
14:03  **1412. Non-Invasive Perfusion Measurements in Term Neonates and Premature Infants at Term-Equivalent Age using Arterial Spin Labelling**  
*Maria J. Miranda*, *Kern Olofsson*, *Karam Sidaros*  
1Copenhagen University Hospital, Hvidovre, Denmark

The purpose of this study was to investigate the feasibility of non-invasive MR perfusion measurements using arterial spin labelling (ASL) in healthy unsedated premature infants at term equivalent age and in term neonates. Examinations were performed at 3T using quantitative ASL. It was found that ASL permits reliable measurements of brain perfusion in unsedated infants. Perfusion was found to be highest in the basal ganglia (BG) and lowest in white matter. Perfusion in BG and cortical grey matter was significantly higher in premature infants at term equivalent age than in term neonates.

14:04  **1413. Quantitative Apparent Diffusion Coefficient Values and T2 Relaxation Rates in Term Neonates with Suspected Hypoxic Ischemic Injury**  
*J. D. Winter*, *N. Gelman*, *D. S. Lee*, *S. Levin*, *R. T. Thompson*  
1Lawson Health Research Institute, London, Ontario, Canada; 2St. Joseph's Health Care Centre, London, Ontario, Canada; 3London Health Science Centre, London, Ontario, Canada

MR studies of term infants with suspected hypoxic ischemic injury (HI) were performed on a 3.0 Tesla system. The $R_2 (R_2 = 1/T_2)$ relaxation rates and apparent diffusion coefficient values were measured in several brain regions. Preliminary results demonstrate that $R_2$ and ADC values at 8-15 days after birth correlate significantly ($p<0.001$). To our knowledge, this is the first study to determine $R_2$ and ADC in human neonates who have suffered HI.

14:05  **1414. Delayed Diffusion Abnormalities in White Matter Following Perinatal Hypoxia-Ischemic Injury to Central Grey Matter: A Late Therapeutic Window?**  
*Mary Rutherford*, *Serena Counsell*, *Joanna Allsop*, *James Boardman*, *Olga Kapellou*, *David Edwards*, *Frances Cowan*, *Yugi Shen*, *David Larkman*, *Jo Hajnal*  
1Imperial College, London, UK; 2Hammersmith Hospital, London, UK

This study used diffusion weighted MR imaging (DWI) to address the question: is there evidence of delayed onset microstructural abnormality in WM of infants with BGT injury and initially normal WM after perinatal hypoxia-ischaemia at term? Infants were scanned during the neonatal period. In control infants ADC values decreased with increasing postnatal age but in infants with BGT lesions ADC values increased significantly. In scans performed after the first week ADC values in anterior WM and posterior WM were significantly higher than both those infants imaged during the first week and from controls. $p<0.05$.

14:06  **1415. Imaging the Neonatal Brain with 3-D MP-RAGE: Optimization of K-space Weighting During the Approach to Steady State**  
*Lori-Anne Williams*, *Neil Gelman*, *Timothy J. DeVito*, *R Terry Thompson*  
1Lawson Health Research Institute, London, Ontario, Canada

3-D MRI has shown great potential for studying the impact of prematurity and pathology on brain development. For the 3-D magnetization-prepared rapid gradient-echo (MP-RAGE) sequence, the optimization of k-space weighting associated with imaging while the signal approaches steady state is investigated experimentally for the increased transverse relaxation times ($T_2 > 200$ ms) in neonatal brain tissue. RF-spoiling using a RF-pulse phase difference increment of 84 (compared to the conventional 117) better approximated the ideally spoiled signal amplitude and phase evolution. In addition, increased gradient dephasing resulted in further improvements in the signal evolution and the elimination of image artifacts.

14:07  **1416. Evolution of Brain Injury During the First Week After Pediatric Respiratory +/- Cardiac Arrest: Serial ADC Changes and Selected CBV Findings.**  
*Melina Pectasides*, *Chloe Joan Lopez*, *Daniel S. Kohane*, *Natan Noviski*, *Michael Whalen*, *A. Gregory Sorensen*, *R. Gilberto Gonzalez*, *P. Ellen Grant*  
1Massachusetts General Hospital, Boston, Massachusetts, USA

We describe the ADC evolution during the first week in 8 pediatric patients with respiratory +/- cardiac arrest. Three patterns of ADC change were identified: 1) acute deep gray nuclei involvement and death in those with cardiac and respiratory arrest and 2) delayed white matter involvement or 3) minimal ADC change with diffuse long term volume loss in those with only respiratory arrest. In a subset, perfusion weighted imaging showed relative hyperperfusion of deep gray nuclei acutely in group 1. A scanning schedule for children admitted with respiratory +/- cardiac arrest is proposed.
**MR Imaging and Spectroscopy of Pediatric Brain**

Swan  Monday 14:00 - 16:00

14:00  **1417. Trace ADC of Metabolites in Human Brain using Diffusion Weighted MRS**

_**Jacob Ellegood**, Chris C. Hanstock, Christian Beaulieu_  
1University of Alberta, Edmonton, Alberta, Canada

Although the diffusion of water in human brain has been thoroughly investigated, there are few reports of metabolite diffusion in human brain. Trace ADC of the metabolites N-acetyl aspartate (NAA), creatine (Cre), and choline (Cho) were measured in the brain of three healthy volunteers using a diffusion-weighted STEAM sequence. Diffusion measurements along three orthogonal axes demonstrated significant anisotropy and yielded Trace ADCs of (0.39±0.04), (0.42±0.07), and (0.37±0.04)x10-3mm2/s for NAA, Cre, and Cho, respectively, in periventricular white matter. A rotationally invariant measure of diffusion such as the Trace ADC is necessary for characterizing metabolite diffusion in human brain.

14:01  **1418. Comparison of Gadobenate Dimeglumine (Gd-BOPTA) with Gadopentetate Dimeglumine (Gd-DTPA) for Enhanced MR Imaging of Brain and Spine Tumors in Pediatric Subjects**

_Cesare Colosimo, P Damaerel, Michael Bourne, Mark Van Buchem, Gianpaolo Pirovano, Miles Kirchin_  
1University of Chieti, Chieti, Italy; 2University Hospital Leuven, Leuven, Belgium; 3University Hospital of Wales, Cardiff, UK; 4University Hospital Leiden, Leiden, Netherlands; 5Bracco Diagnostics Inc., Princeton, New Jersey, USA; 6Bracco Imaging Spa, Milan, Italy

Sixty-three pediatric subjects with confirmed brain or spine tumors underwent MR imaging before (T1w- and T2wSE sequences) and after (T1wSE sequences only) injection of either Gd-BOPTA (n=29) or Gd-DTPA (n=34) at a dose of 0.1 mmol/kg BW. Blinded qualitative evaluation revealed significant superiority for Gd-BOPTA for contrast enhancement (p=0.06) and lesion border delineation (p=0.018). Quantitative comparison revealed superiority for Gd-BOPTA over Gd-DTPA for lesion-to-brain contrast, contrast-to-noise ratio and percent enhancement. The superior contrast enhancement may be clinically advantageous in pediatric subjects for the detection and diagnosis of small or poorly enhancing CNS tumors.

14:02  **1419. Quantifying the Impact of Irradiation Dose on Normal White Matter Volume Development in Children**

_Wilburn E. Reddick, Qing Ji, John O. Glass, Amar Gajjar, Thomas E. Merchant_  
1St. Jude Children's Research Hospital, Memphis, Tennessee, USA

This project combines 640 quantitative longitudinal MR examinations of 61 children treated for medulloblastoma or ependymoma with fused digital composite irradiation dosimetry to establish the response of normal-appearing white matter (NAWM) to varying doses of therapeutic irradiation. Changes in the NAWM volume per year were observed to have positive growth for very low dose levels, which is expected in normal maturation but trended toward larger declines with increasing dose exposure. A significant relationship between intensity of irradiation and change in NAWM volumes (F=9.16; p=0.0036) was established. Low NAWM volumes have been previously associated with deficits in neurocognitive function.

14:03  **1420. A Randomised Trial of Botulinum Toxin A and Upper Limb Training in Children with Congenital Hemiplegia: A Serial fMRI Study**

_Roslyn Nancy Boyd, David Abbott, Timothy Bach, Meg Morris, Christine Imms, H Kerr Graham, Ari Syngeniotis, Graeme Jackson_  
1Murdoch Children's Research Institute, Melbourne, Australia; 2Brain Research Institute, Melbourne, Victoria, Australia; 3La Trobe University, Melbourne, Victoria, Australia

In a matched pairs single blind randomised trial we examined the neurovascular changes associated with Botulinum toxin A (BTX-A) and upper limb training in children with congenital hemiplegia. Serial fMRI was undertaken over a 12 week period. There is evidence that brain reorganisation was greater in the BTX-A treated group and extended beyond the pharmacological effect of BTX-A.

14:04  **1421. Transverse Relaxation Changes in Tourette Syndrome**

_J. D. Hendry, T. J. DeVito, N. Gelman, W. Pavlosky, N. Rajakumar, P. Williamson, R. Nicolson_  
1University of Western Ontario, London, Ontario, Canada; 2Lawson Health Research Institute, London, Ontario, Canada

Only one study, in adults, has shown T2 abnormalities in Tourette Syndrome (TS). We hypothesize that children with TS should also have T2 abnormalities. Eleven boys with Tourette Syndrome and nineteen healthy control subjects were scanned with the GESFIDE technique that generates transverse relaxation rate (R2 = 1/T2) maps. Patients with Tourette syndrome showed abnormal patterns of T2 asymmetry in the frontal white matter (p=0.03). This result coincides with the previous adult study of T2 in Tourette syndrome, however T2 abnormalities found in other regions in that study were not detected here.
Correlations of Cerebral Metabolite Levels with Cognition in Children with Pervasive Developmental Disorder: A Preliminary 1H MRS Study

Wei Huang1, Allen Azizian1, Alina Tudorica1, Carla DeVincent2, Patricia Roche2, John Pomeroy2, Lidia Gabis2
1Memorial Sloan-Kettering Cancer Center, New York, USA; 2State University of New York, Stony Brook, New York, USA

The goal was to determine if regional cerebral metabolic abnormalities are related to cognitive dysfunctions in children with Pervasive Developmental Disorder (PDD), of which the underlying neuropathology is unclear. Single-voxel proton MR spectra were acquired from the left and right hippocampus-amygdala regions and the cerebellum. The metabolite ratios were correlated with scores of neuropsychological tests. NAA/Cr was inversely related to, while mI/Cr was positively associated with cognitive performances. The findings of this preliminary study suggest that 1H MRS may be an important noninvasive approach in understanding the neurochemical nature of PDD.

1H MR Spectroscopy and Relaxometry for the Determination of Iron and Metabolite Concentrations in Hallerworden-Spatz Syndrome Patients

Milan Hajek1, Miriam Adamovicova2, Vit Herynek1, Monika Dezortova1, Antonin Skoch1, Filip Jirka1
1Institute for Clinical and Experimental Medicine, Prague, Czech Republic; 2Faculty Thomayer Hospital, Prague, Czech Republic

The influence of iron deposits on T2 and the content of metabolites in the brain of three patients with Hallerworden-Spatz syndrome was studied. T2 values in the white matter are decreased by about 5%, in the globus pallidus the change is about 40% (70/44 ms controls vs. patients) which corresponds to the increase of Fe concentration up to 300%. A significant decrease in Cho concentration was found in white matter, in the area of the globus pallidus, the character of the spectra is changed due to susceptibility effects; nevertheless, significant decreases of Cr, Cho, and NAA were observed.

Evidence of Altered Membrane Phospholipid Metabolites in Children with Attention Deficit-Hyperactive Disorder (ADHD): An In Vivo 31P Spectroscopy Study

Jeffrey A. Stanley1, Heidi Kipp2, Erika Greisenegger1, Kanagasabai Panchalingam1, Jay W. Pettigrew1, Matcheri S. Keshavan1, Oscar G. Bukstein1
1University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, USA; 2Western Psychiatric Institute and Clinic, Pittsburgh, Pennsylvania, USA

The neurodevelopmental disorder, attention deficit-hyperactive disorder (ADHD), is one of the most prevalent childhood behavioral disorders, affecting approximately 7% of the population. Neuroimaging findings have primarily implicated the basal ganglia and prefrontal regions, which are regions associated with the neural networks of attention. The purpose of this study is to assess possible molecular/biochemical alterations in children with ADHD compared to age- and gender-matched controls using in vivo phosphorus (31P) spectroscopy. Results show significant membrane phospholipid metabolism alterations in children with ADHD suggesting an underdevelopment of neuronal processes and synapses in regions that are involved in the function of attention.

Magnetic Resonance Imaging of Animal Brain: White Matter Maturation

MRI of Animal Brain: White Matter

Room 157 Monday 14:00 - 16:00

Brain White Matter and Cortex Maturation Monitored by Combined DTI and T2 Measurements

Setsu Wakana1, Jiangyang Zhang1, Lidia Nagae-Poetscher1, Hangyi Jiang1, Peter van Zijl1, Susumu Mori1
1Johns Hopkins University, Baltimore, Maryland, USA

Different brain regions have different maturation rates during development. T2 relaxation is known to be sensitive to the maturation, but, contrary to DTI provides poor anatomical information in neonates. We acquired DTI and T2 maps of pediatric brains and used DTI as anatomical guidance to quantify T2 and FA of individual white matter tracts. The approach was first applied to mouse neonate postmortem samples and then healthy human volunteers. Results indicate characteristic maturation patterns for cortex and white matter tracts. Using this approach, we are establishing a normal database to quantitatively characterize the brain maturation process.

How Do T1-, T2- and MT-Weighted Images Reflect De- and Remyelination? In Vivo MRI of Mice Treated with the Demyelinating Neurotoxic Agent Cuprizone

Susann Boretius1, Doron Merkler2, Nagmy Awn2, Christine Stadelmann1, Oliver Natl1, Takashi Watanabe1, Thomas Michaels2, Jens Frahm1, Wolfgang Brück2
1MPI für Biophysikalische Chemie, Goettingen, Germany; 2Georg-August-Universität, Goettingen, Germany

An important goal in the treatment of multiple sclerosis (MS) is to promote remyelination. Although representing the gold standard in MS diagnosis, it is not yet clear to which degree MRI reflects specific aspects of demyelination and remyelination. The capability of T1-, T2- and MT-weighted MRI to detect de- and remyelination was evaluated using the cuprizone C57/BL6 mouse model. The results indicate that histologically confirmed areas of demyelination cause a loss of the T1-weighted MRI signal and increased intensities in T2- and MT-weighted images. Remyelination was reflected in a partial recovery of respective signals.
14:02  **1427. FAIR Perfusion Measurements in the Neonatal Piglet**

Andrew Nicholas Priest¹, Alan Bainbridge², John Stephen Thornton², Osuke Iwata³, Shanthi Shanmugalingam³, Sachiko Iwata³, Roger Ordidge², John S. Wyatt², Ernest Brunton Cady¹

¹UCL Hospitals NHS Trust, London, UK; ²University College London, London, UK

An established piglet model of perinatal hypoxia-ischaemia demonstrates a delayed secondary energy failure. To understand this model further we require repeated non-invasive cerebral perfusion measurements. We present a semi-quantitative perfusion technique, based on FAIR, for use in this model. FOCI pulses were used for both inversion and imaging, to optimise the usable slice-thickness ratio (STR) between selective inversions and the imaging slice, reducing the inflow time of labelled blood. From measurements on 7 neonatal piglets the baseline perfusion values in subcortical white matter were (mean±sd) 38±8 ml/100g/min.

14:03  **1428. Diffusion Tensor Imaging of the Developing Rabbit Brain**

Alexander Drobyshevsky¹, Stephen Back², Alice M. Wyrwicz², Limin Li³, Mathew Derrick¹, Xinhai Ji¹, Mathew Kotlajich¹, Sidhatha Tan¹

¹Evanston Northwestern Healthcare, Evanston, Illinois, USA; ²Oregon Health Sciences University, Portland, Oregon, USA; ³Center for MR Research, Evanston, Illinois, USA

The developmental changes of white matter in rabbits were studied by diffusion tensor imaging on postnatal days 1, 5 and 11. Diffusion parameters were calculated, and average values were obtained for major fiber tracts, and other areas. Fractional anisotropy in the white matter significantly increased with age in white matter tracts, such as internal capsule and corpus callosum and decreased in gray matter structures, such as hippocampus and cerebral cortex. T2 values also significantly decreased with age in white and gray matter structures. The biggest changes occurred prior to myelination as well as with myelination in rabbit white matter tracts.

14:04  **1429. ADC Changes with Temperature in Neonatal Porcine Brain**

Andrew Nicholas Priest¹, Alan Bainbridge², John Stephen Thornton², Osuke Iwata³, Shanthi Shanmugalingam³, Sachiko Iwata³, Roger Ordidge², John S. Wyatt², Ernest Brunton Cady¹

¹UCL Hospitals NHS Trust, London, UK; ²University College London, London, UK

Hypothermia is a promising neuroprotective therapy against secondary energy failure following perinatal hypoxia-ischaemia. Such therapeutic brain cooling can be monitored non-invasively using 1H MR spectroscopy. In normothermic brain, diffusion-weighted imaging reveals local pathology during SEF. However the apparent diffusion coefficient changes with temperature, so must be characterised to permit interpretation of diffusion measurements during hypothermia. We have studied the temperature dependence of ADC in the normal neonatal piglet brain. Hypothermia was induced with both whole-body cooling and a water-cooled cap. The average ADC change was 2.0%/°C. Future work will address whether this is dependent on anatomical location.

14:05  **1430. Comparison of Apparent Diffusion Coefficient of Water to Histology in a Model of Hypoxia-Ischemia in New-Born Brain**

Alan Bainbridge², Osuke Iwata³, Daniel A. West³, Jeanie LY Cheong³, Andrew N. Priest³, Ernest B. Cady³, Shanthi Shanmugalingam³, Gennadij Raivich³, Roger J. Ordidge², John S. Wyatt², Nicola J. Robertson³

¹University College Hospitals NHS Trust, London, UK; ²University College London, London, UK; ³Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany

Diffusion weighted imaging (DWI) and apparent diffusion coefficient (ADC) parameter mapping are relatively new methods for the clinical evaluation of infants who have suffered perinatal hypoxia-ischemia (HI). The purpose of this study was to correlate changes in ADC to histology of the brain in a piglet model of cerebral HI. The data showed that a marked reduction in ADC during secondary energy failure correlates to large-scale neuronal death in this neonatal model. However, mild to moderate changes on histology did not show a corresponding change in ADC.

**Transgenic Mouse Models of Brain**

Room 157  Tuesday 13:30 - 15:30

13:30  **1431. Evolving White Matter Injury in Alzheimer’s Disease Mouse Model Characterized by Diffusion Tensor Imaging**

Shu-Wei Sun¹, John J. Kotyk², Shiow-Jiuan Lin¹, Kalpana M. Merchant³, David M. Holtzman¹, Sheng-Kwei Song¹

¹Washington University, St. Louis, Missouri, USA; ²Pfizer, Inc, St. Louis, Missouri, USA; ³Lilly Corporate Center, Indianapolis, Indiana, USA

In order to resolve inconsistent findings in human studies, characterization of rapidly progressing transgenic mouse models of AD provides a focused etiology and may help eliminate sources of variability in the study. In addition, transgenic mouse models allow opportunities for temporal measurement of disease progression in reasonably short periods of time that could add to the understanding of the evolution of AD. The study described herein examines APPsw mice and wild type age-matched control mice at four different ages (8, 12, 16, and 18 months).
13:31 MRI Detection of Early Regional CBV Reduction in Alzheimer’s Disease Mouse Model (APP<sup>V717F</sup>)

*Ed X. Wu*, *Haixing Tang*, *Tomoshiro Asai*, *Taichi Sakaguchi*, *Martin Andrassy*, *Shidu Yan*

1Columbia University College of Physicians & Surgeons, New York, New York, USA

The contribution of vascular factors to the etiology of dementia, with particular attention to Alzheimer’s disease (AD) has become a rapidly extending research field in the last decade. In this study, the regional CBV maps in APPV717F mice, a widely studied AD mouse model, were studied with high-resolution MRI using an intravascular contrast agent MION and steady-state T2-weighted MRI. Regional analysis of the multi-slice CBV maps revealed statistically significant CBV reductions among APPV717F mice in cerebral cortex, hippocampus, and thalamus, indicating an early change of microvasculature in these selected regions.

13:32 Visualizing Amyloidal Deposition in a Transgenic Mouse by MRI


1University of Pennsylvania, Philadelphia, Pennsylvania, USA

A T1<sub>ρ</sub>-weighted MRI pulse sequence was developed and optimized to visualize Aβ plaque deposits in the mouse brain in vivo. Two 18-month old APP/PS1 transgenic mice and two age-matched controls were imaged at 78µm in-plane resolution and matched with their corresponding immuno-stained histological sections. Evident in the MR images are regions of hypo-intensity which correspond to Aβ plaque deposits in the histology.


1Nathan Kline Institute, Orangeburg, New York, USA; 2Fox Chase Cancer Center, Philadelphia, Pennsylvania, USA

An image warping algorithm has been implemented and applied to register volumetric and T2 maps from MRI brain scans of transgenic mice. The algorithm successfully registered 27 mouse brain MRI volumes and T2 maps, allowing a reliable measurement of T2 for different regions of interest.

13:34 MR Phenotyping: The Importance of Utilizing Numerous MRI Protocols to Characterize New Mouse Mutants

*Nir Lifshitz*, *Lorinda M. Davidson*, *Helen O. Cheung*, *Chi-chung Hui*, *X. Josette Chen*

1The Hospital for Sick Children, Toronto, Ontario, Canada

In vivo, manganese-enhanced MRI was used in conjunction with in situ, high resolution MRI to effectively characterize a novel murine mutation of the hedgehog signaling pathway. The in vivo images showed enlarged ventricles in the mutants (n=2) relative to that of a control mouse (n=1). Images acquired 48 hrs. post-injection of MnCl<sub>2</sub> revealed undersized and less intense olfactory bulbs in the mutants, compared to the control. In situ images showed enhanced ventricles in the mutant indicating presence of the contrast agent in the CSF. This is indicative of a malfunctioning blood-cerebral spinal fluid barrier located at the choroid plexus.

13:35 Reduced Anisotropy in Hippocampal Subfields in a Mouse Model of AD

*P N. Venkatasubramanian*, *Omur M. Cheema*, *Alice M. Wyrvicz*

1ENH Research Institute, Evanston, Illinois, USA; 2Northwestern University, Evanston, Illinois, USA

Structural changes were detected prior to amyloid plaque deposition in specific hippocampal regions of APP Tg2576 transgenic mice using diffusion MR imaging. Tg2576 mice are a model of amyloidogenesis, a well-known pathophysiological feature of Alzheimer’s disease. Our results suggest that changes in cerebral microstructure occur well before amyloid plaque deposition and diffusion imaging has potential in detecting those changes in humans.

13:36 Vascular Territory Mapping using ASL Measurements of Arterial Transit Time

*Mark F. Lythgoe*, *David L. Thomas*, *David G. Gadian*

1Institute of Child Health, London, UK; 2University College London, London, UK

Characterisations of arterial vascular territories within the brain may provide useful information on intracerebral vessel architecture, collateral flow and cerebrovascular disease, which is relevant to both clinical and experimental settings. In this study we investigated the use of arterial transit times measured with arterial spin labelling (ASL) to calculate vascular territories maps (VTM) in the rat brain. Confirmation of the arterial anatomical distribution is made by comparison of the VTM pre-occlusion with CBF maps following occlusion of one middle cerebral artery in the rat.

13:37 Screening Mutagenic Mice with Ventricular Mutation

*Yi-Ling Lee*, *Yu-Yin Tung*, *Chung-Yi Hong*, *Chen Chang*

1Academia Sinica, Taipei, Taiwan

To screen mice with ventricular mutation, a normal mouse ventricular volume library (NMVVL) of different age groups and ventricular compartments is established from the high resolution 3-D T2-weighted MRI images. The ventricle of a mutagenic mouse is then compared with NMVVL for a primary screening test.
13:38  **1439. Automated Image Analysis of Many Mouse Brains**
Natasa Kovacevic¹, Nicholas A. Bock¹, Jeffrey T. Henderson¹, Nir Lifshitz¹, Jonathan Bishop¹, R Mark Henkelman¹, X Josette Chen¹
¹Hospital for Sick Children, Toronto, Ontario, Canada; ²University of Toronto, Toronto, Ontario, Canada

We investigated pipelining image analysis methods for processing large numbers of mice with controlled backgrounds. We developed a method for creating an average image to reduce a manual segmentation task to a single, high quality image. This segmentation of the average brain gives segmentation of the individuals in the entire group automatically. In this work we demonstrate the robustness of our pipelining by measuring the volume of the cerebellum compared to the whole brain in two different image datasets: nine 129Sv excised mouse brains and five C3H live mouse brains.

**Cerebral Disease Models**

Room 157    Thursday 13:30 - 15:30

13:30  **1440. Measuring the Iron Content of Gray Matter with T2 and T2* MR Imaging**
Peter Andrew Hardy¹, Zhiming Zhang¹, Richard Grondin¹, Robert Yokel¹, Anders H. Andersen¹, Don M. Gash¹
¹University of Kentucky, Lexington, Kentucky, USA

We have assessed the accuracy of T2 and T2* for estimating the concentration of iron in the gray matter regions of the brains of rhesus monkeys. Both 1/T2 and 1/T2* have linear dependencies on iron concentration.

13:31  **1441. Implications of Temperature Changes in the Brain for fMRI**
Hubert KF Trubel¹, Ikuhiro Kida¹, Fahmeed Hyder¹
¹Yale University, New Haven, Connecticut, USA

Brain temperature is one of many critical factors for BOLD signal because changes in CBF and CMRO2 during perturbation are involved in heat removal/production. We examined temperature changes (by thermocouple) in localized regions of rat cortex with several perturbations which demonstrate a positive BOLD signal-change (i.e., ΔS/S>0). When ΔS/S>0 (hypercapnia challenge, bicuculline-induced seizure) the temperature changes were significant (0.9-1.2°C), whereas during sensory stimulation the temperature changes were small (~0.1°C). Thus, local changes in temperature could be an indicator of the degree of the mismatch between CBF and CMRO2 during perturbations. Influence of brain temperature for BOLD signals is discussed.

13:32  **1442. A Combined Diffuse Optical Tomography (DOT) - MRI System for Small Animal Imaging**
Gultekin Gulsen¹, Ozlem Birgul¹, Bin Xiong¹, Orhan Nalcioglu¹
¹University of California, Irvine, California, USA

Multi-modality imaging techniques can improve the measurements done by either modality as well as providing cross validation measurements. MRI and near-infrared diffuse optical tomography (DOT) are two techniques that, when combined, can provide complementary structural and functional information. MRI can be used to obtain detailed structural and metabolic information regarding tumors while DOT can be used to determine local quantitative information regarding tumor composition and metabolism. Thus, a combined system consisting of MRI and DOT has the potential to enhance understanding of the complex biological processes in tumors. In this work, we describe the design of a hybrid DOT-MRI system.

Bram Stieltjes¹, Stefan Klussmann¹, Michael Bock¹, Ana Martin-Villalba¹, Marco Essig¹
¹German Cancer Research Center, Heidelberg, Baden-Württemberg, Germany

The blood-spinal cord barrier (BSCB) preserves a highly regulated environment surrounding the spinal cord and prevents intravascular substances from moving into this compartment. Experiments have shown that increased permeability of the BSCB occurs after spinal cord injury (SCI) in rats. This is of great importance for drug delivery in animal models of SCI since the time frame of increased permeability of the BSCB determines the therapeutic window. Experimental SCI therapy is increasingly evaluated in mice. In vivo data on the response of mouse BSCB after SCI is not available. Here we report first data on mouse BSCB response to SCI.

13:34  **1444. Quantitative Measures of T1 and T2 Relaxation Time in Prion Disease**
Kerry Anne Broom¹, John Lowe¹, Andrew Blamire¹, V Hugh Perry¹, Peter Styles¹, Nicola Sibson¹
¹University of Oxford, Oxford, UK; ²University of Southampton, Southampton, UK

Prion disease or Transmissible Spongiform Encephalopathies (TSE) are fatal neurodegenerative diseases. In this study, we have used a mouse model of Prion disease to investigate early T1 and T2 relaxation time changes. An increase in the T1 and T2 relaxation times of the hippocampus is observed at 14 weeks post-induction. These quantitative changes coincide with the onset of microglial activation and loss of synapses, and may provide an early diagnostic marker for Prion disease.
Hippocampal volume loss in major depression supposedly results from elevated levels of glucocorticoids. To further investigate steroid-associated hippocampal pathology, rats with long-term alterations of the corticosteroid milieu were examined by in vivo MR-morphometry and proton spectroscopy at 7T. Depletion of corticosteroids by adrenalectomy was characterized by hippocampal volume loss, consistent with historical evidence of neurodegeneration. Also, the known neuroprotective effect of low dose glucocorticoid substitution was confirmed by MR morphometry. Further detrimental effects of dexamethasone were not, however, reflected by MR volumetry but led to metabolic changes (increased glutamate, decreased glucose) indicating steroid-induced excitotoxicity.

13:36  **1446. MR Visualization of Tumor Angiogenesis**  
Lauren Marie Brubaker, Elizabeth Bullitt, Chaoying Yin, Weili Lin  
1University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Upregulation of vascular endothelial growth factor and the subsequent cascade of molecular and cellular events lead to the abnormal growth of tortuous vessels within tumors. Therefore, most of the studies to date focus on the utilization of vascular density as a means to determine the malignancy of tumors and relatively little attention has been given regarding the vessel morphology with respect to the tumor. To this end, a transgenic mouse model, choroid plexus (CPP) brain tumor, was employed as an experimental model and MRA was utilized in this study for the investigation of tumor vascular morphology.

13:37  **1447. MRI Measurements Following Chronic Bilateral Common Carotid Occlusion in Newborn and Adult Rats: A Model for Moyamoya Syndrome?**  
ManKin Choy, Mark Lythgoe, Vijaya Ganesan, David L. Thomas, Louise van der Weerd, John Thornton, David Gadian  
1Institute of Child Health, London, UK; 2University College London, London, UK

We have investigated a chronic bilateral common carotid artery occlusion (BCCAO) model in newborn and adult rats with the goal of developing an animal model of moyamoya syndrome (MMS) using diffusion, perfusion and angiographic MR. MMS is a cerebral vasculopathy with bilateral stenosis of the internal carotid arteries and the presence of basin collateral vessels. No structural changes were observed in the brain 6 months post-surgery. Cerebral blood flow (CBF) decreased acutely following BCCAO but had recovered 6 months later. The restoration of CBF at 6 months may be associated with the formation of extra-cerebral collaterals observed on MR imaging.

13:38  **1448. Development of Experimental Meningitis in Rats Studied using MRI**  
Christian Brandt, Helle Jul Simonsen, Lise Vejby-Søgaard, Christian Østergaard, Ian John Rowland  
1State Serum Institute, Copenhagen, Denmark; 2Danish Research Centre for Magnetic Resonance, Hvidovre, Denmark

The aims of this study were to follow the evolution of experimental meningitis in a rat model and to stage the disease using MR imaging methods. Using post contrast T1W and quantitative diffusion images, enhancement of the meninges and hydrocephalus was used to obtain a MR grade. Motor, clinical, and paraclinical data were obtained and a significant correlation with the MR scores was found. This study suggests that the meningitis model could be used together with MR to assess and optimize the efficacy of adjunctive treatments directed at meningitis and complications in the course of disease.

13:39  **1449. MRI Reveals BBB Breakdown and Alterations in Hippocampal T2 in Murine Cerebral Malaria**  
Daniel J. Stuckey, Daniel C. Anthony, Isabelle M. Medana, John P. Lowe, Peter Styles, Andrew M. Blamire, Nicola R. Sibson  
1University Of Oxford, Oxford, UK; 2University of Southampton, Southampton, UK; 3John Radcliffe Hospital, Oxford, UK

Although cerebral malaria is a serious health problem, the exact cause of death is not well understood. This study is the first to use MRI to investigate a well-characterised murine model of cerebral malaria in vivo. We have identified global breakdown of the BBB, in addition to focal areas of more overt breakdown and alterations in hippocampal T2 in mice with terminal cerebral malaria. This study suggests that MRI will be a useful method for studying the pathology of cerebral malaria, and may yield new information on the mechanisms of the disease and response to treatments.

Louise van der Weerd, Mark Lythgoe, Romina Aron Badin, Martin King, David Latchman, David Gadian  
1Institute of Child Health, London, UK

Protective effects of heat shock proteins after cerebrovascular ischaemia were studied by measuring diffusion maps and estimating the total lesion size using a multi-slice T2-weighted scan. The lesion in HSP70-overexpressing mice was 30% smaller than in WT animals. After 1.5 hours of ischaemia, the ADC continues to decrease for HSP70 mice, whereas in WT ADC increases again. These results suggest that HSP70 reduces the lesion size and may also limit the tissue damage within the lesion.
13:41  **1451. MRI Visualization of MOG-Induced Opticus Neuritis in a Rat Model of EAE**  
*Susann Boretius¹, Iris Demmer², Ricarda Diem², Jens Frahm³, Mathias Baehr⁴, Thomas Michaelis⁵*
¹MPI für biophysikalische Chemie, Goettingen, Germany; ²Georg-August-Universität, Goettingen, Germany

Multiple sclerosis is frequently accompanied by neuritis of the optic nerve. Two weeks after immunization with myelin oligodendroyte glycoprotein most female brown Norway rats developed neuritis of the optic nerve which could be detected by signal reductions in T1-weighted and corresponding signal increase in T2-weighted images. Application of Gd-DTPA results in an enhancement of the optic nerve borders while manganese stained the central parts of the optic nerve. These findings support the role of MRI in the detection of possibly inflamed optic nerve in experimental autoimmune encephalomyelitis. The results are expected to help in the development of new therapeutics.

13:42  **1452. Acute Hypotension Reduces Venous Cerebral Blood Volume**  
*Yueh Z. Lee¹, Weili Lin¹*
¹University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Acute hypotension causes an apparent reduction of vCBV in rats as measured using a single scan blood volume measurement technique.

13:43  **1453. Postnatal Brain Maturation in Rabbits Studied by Combined NIRS and MRI**  
*Helen D’Arceuil¹, Merja Hotakainen¹, Christina Liu¹, Alex de Crespigny¹, Mari-Angela Franceschini¹*
¹Massachusetts General Hospital, Charlestown, Massachusetts, USA

Near infrared frequency domain optical spectrometry (NIRS) and magnetic resonance imaging (MRI) was used to follow changes in postnatal hemodynamics and cerebral structure respectively. Oxy-hemoglobin concentration ([HbO2]), deoxy-hemoglobin concentration ([HbR]), total hemoglobin concentration (HbT), and hemoglobin saturation (StO2) were measured during post natal development in normal and hypoxic-ischemic (HI) rabbit brains. StO2 measured optically reflects blood oxygenation concentration found in the microvasculature and increased steadily up to post natal day 76, while HbT reflects blood volume which peaked at day 17. Our data suggest that transient HI may not result in permanent changes in tissue oxygenation and blood volume.

13:44  **1454. Age-Dependent Regional Cerebral Blood Volume (rCBV) in Gray Matter and White Matter of the Canine Brain**  
*Yong Chu¹, Dwight Tapp¹, Jr-Yuan Chion¹, Norton William Milgram³, Orhan Nalcioglu¹, Min-Ying Su¹*
¹University of California, Irvine, California, USA; ³Chang-Shan Medical University, Taichung, Taiwan; ¹University of Toronto, Toronto, Ontario, Canada

The effects of age on regional cerebral blood volume (rCBV) in gray and white matter using dynamic contrast perfusion MRI was examined in young and old beagle dogs. Age-related decreases were found in gray and white matter rCBVs but occurred earliest in white matter. Old and senior dogs exhibited greater decreases compared to infant dogs. These findings indicate that age-related decreases in rCBV in white matter occur before similar changes in gray matter in beagle dogs and may have implications for amyloid deposition in the dog brain, which occur around the same age as decreases rCBV in the white matter.

13:45  **1455. Hypoxia Induced Changes in the Brain of Hypoxic Tolerant Cuttlefish Sepia officinalis**  
*Christian Bock¹, Susann Schmidt¹, Frank Melzner¹, Hans-O. Poertner¹*
¹Alfred-Wegener-Institute, Bremerhaven, Bremen, Germany

A setup for *in vivo* MR imaging and spectroscopic studies on *Sepia officinalis* (Cephalopoda) was developed in order to assess the effects of varying physical conditions on physiological key parameters in the brain of this invertebrate. Animals were subjected to hypoxia (PO2 < 6.4 kPa, 90 minutes) while blocks of flow weighted MRI, T2* weighted MRI and 31P – spectroscopy were collected in series. Blood flow in coronary vessels decreased during hypoxia, while no change in BOLD contrast was observed. [Phosphate] / [Phospho-L–Arginine] ratios increased, indicating anaerobiosis. Recovery to control values could be observed after 30 minutes of normoxia.

13:46  **1456. Increased T1 and Decreased MTR Detected in an Excitotoxic Lesion in Rat Brain in the Absence of Perfusion Changes**  
*Nicola Sibson¹, John Lowe¹, Peter Styles¹, Andrew Blamire¹, Daniel Anthony²*
¹University of Oxford, Oxford, UK; ²University of Southampton, Southampton, UK

Recent rodent studies performed at high magnetic fields have reported increases in T1 relaxation as a consequence of reduced perfusion, which are not observed at lower field strengths. Here we investigate further T1 relaxation changes in brain tissue using a model of excitotoxicity. In this model we have found a significant elevation in T1 together with significant reductions in ADC and MTR, in the absence of changes in cerebral perfusion and BBB breakdown. We suggest that the increased T1 relaxation time observed may reflect either changes in the protein content of the tissue or alterations in tissue structure.
**Experimental Cerebral Ischemia**

Room 157  Monday 14:00 - 16:00

14:00  **1457. Temporal Evolution of the Diffusion/Perfusion Mismatch in a Rat Model of Focal Cerebral Ischemia**

Xiangjun Meng¹, Qiang Shen, Christopher H. Sotak², Timothy Q. Duong, Marc Fisher¹

¹UMass Memorial Medical Center and UMass Medical School, Worcester, Massachusetts, USA; ²Worcester Polytechnic Institute, Worcester, Massachusetts, USA

In a permanent and 60 minutes temporary focal experimental ischemia rat model, we evaluated the temporal evolution of the DWI/PWI mismatch that has been reported in clinical studies. We demonstrated a significant mismatch exists between PWI and DWI lesion volumes up to 60 minutes after MCAO. Reperfusion at 60 minutes after MCAO can save the ischemic tissue in the mismatch region from further evolution to infarction.

14:01  **1458. Pixel-by-Pixel Spatiotemporal Progression of Focal Ischemia Derived using Quantitative Perfusion and Diffusion Imaging**

Qiang Shen¹, Xiangjun Meng¹, Marc Fisher¹, Christopher H. Sotak², Timothy Q. Duong¹

¹University of Massachusetts Medical School, Worcester, Massachusetts, USA; ²Worcester Polytechnic Institute, Worcester, Massachusetts, USA

Pixel-by-pixel spatiotemporal progression of focal ischemia (permanent occlusion) in rats was investigated using quantitative perfusion and diffusion MRI every 30mins for 3hrs. Based on the viability thresholds, three pixel clusters (normal, ischemic core, and perfusion-diffusion mismatch) were identified on the CBF-ADC scatterplots. These clusters were color-coded and mapped onto the image and CBF-ADC spaces. In contrast to the CBF distribution, the ADC distribution in the ischemic hemisphere was bimodal and time invariant. Together, these results demonstrated an analysis approach to systemically pixel-by-pixel track the spatiotemporal progression of acute ischemic brain injury using quantitative perfusion and diffusion imaging.

14:02  **1459. Dynamic Dephasing Contrast in Developing Cerebral Ischaemic Infarction in Rat**

Martin Kavec¹, Olli Gröhn¹, Piia Valonen¹, Michael Garwood², Risto Kauppinen¹

¹University of Kuopio, Kuopio, Finland; ²University of Minnesota, Minneapolis, Minnesota, USA

Carr-Purcell (CP) T₂ MRI was used to assess dynamic dephasing effects in developing rat cerebral infarct. We acquired CP-T₂ using the same echo time and different interpulse interval along with diffusion MRI. Reduced susceptibility was observed between days 2 and 3 post-stroke. Since low susceptibility contrast did not develop during early ischaemia, low diffusion or pH-dependent chemical exchange may not explain the observation. Time course of the altered susceptibility contrast, however, closely follows spin density change due to oedema, known to be associated with reduced magnetization transfer effect, as well as tissue structure possibly affecting inherent microscopic susceptibility gradients.

14:03  **1460. A Spontaneously Reversible Diffusion Weighted Signal Intensity Changes Following Neonatal Hypoxia-Ischemia**

Jelena Lazovic¹, Shannon G. Stepanian¹, Michael B. Smith¹

¹Penn State College of Medicine, Hershey, Pennsylvania, USA

MR imaging was utilized to study the evolution of the brain injury following hypoxia-ischemia (HI) in the neonatal rat before and after a drug treatment. Two drugs, minocycline and aminoguanidine were given as neuroprotective agents following hypoxia-ischemia. The volume of the hyperintense diffusion weighted (DW) signal before administration of the drug was compared to the T₂-weighted hyperintense signal volume at 7 days following the recovery from HI. There was a significant difference (p<0.0005) in the hyperintense signal volume reduction for both drug-treated and control (saline and PBS injected) animals.

14:04  **1461. MR Imaging of Convective Delivery of Gadolinium-labeled Liposomes in Rat and Monkey**

Tracy Richmond McKnight¹, Pamela Rose Jackson¹, Ryuta Saito¹, John R. Bringas¹, Christoph Mamo¹, Evelyn Proctor¹, Mitchell S. Berger¹, John Park¹, Krys Bankiewicz¹

¹University of California, San Francisco, San Francisco, California, USA

Convection-enhanced delivery of liposomes containing therapeutic agents is currently being investigated as a method for treating intracranial tumors. The effectiveness of any local chemotherapy depends on the ability to treat the entire tumor while sparing normal surrounding tissue. We describe MRI acquisition and processing methods for monitoring the distribution of convectively-delivered liposomes containing gadolinium (Gd-liposomes). Methods for quantifying the distribution of infused Gd-liposomes in rat brain and for visualizing the time course of liposomal infusion in primate brain are described. The combined results demonstrate the feasibility of using MRI to monitor CED of liposomal therapies in a clinical setting.
14:05 1462. Magnetic Resonance Imaging Studies on the Effect of the Antithrombotic Agent Acutobin on a Rat Model of Embolic Stroke
Jingna Wei1, Edward L. Ezell1, Qingchuang Wang2, Guanfeng Liu2, Michael J. Quast1
1University of Texas Medical Branch, Galveston, Texas, USA; 2Fujian Medical University, Fuzhou, Fujian, People's Republic of China

We conducted a study by using proton MRI to evaluate the efficacy of antithrombotic agent Acutobin on a rat thrombotic MCAO model. Treatment was begun 1h after MCAO. Animals accepted intravenous infusion of Acutobin (2.5U/kg) or saline. The proton MRI measured vasogenic edema and perfusion deficit were significantly reduced at 24h after MCAO in the Acutobin-treated rats compared to the saline controls.

14:06 1463. Acutely Elevated Diffusion Anisotropy in a Nonhuman Primate Stroke Model
Alex de Crespigny1, Yutong Liu1, Julian He1, Mike Duggan1, Gil Gonzalez1, Helen D'Arceuil1, Johnny Pryor1
1Massachusetts General Hospital, Boston, Massachusetts, USA

Previous DTI studies of stroke in humans and rats have demonstrated elevated fractional anisotropy (FA) during hyperacute stroke. We used EPI diffusion tensor imaging to measure FA and ADC-trace from the hyperacute through the chronic stage in a nonhuman primate model of stroke. Monkeys received transient (n=2) or permanent (n=2) occlusion of the middle cerebral artery using an endovascular approach. Animals were scanned immediately on a GE 1.5T scanner, and again at intervals up to 30 days. FA was elevated acutely in two animals but normal in the other two. All animals showed decreased FA at later times.

14:07 1464. Effect of Combined Treatment with rt-PA and GPIIb/IIIa Inhibitor on Embolic Stroke in Rat
Guangliang Ding1, Quan Jiang1, Li Zhang1, Zhenggang Zhang1, Robert A. Knight1, Lian Li1, James R. Ewing1, Ying Wang1, Michael Chopp1
1Henry Ford Hospital, Detroit, Michigan, USA

Rt-PA in combination with 7E3 F(ab’)2 was employed to treat rats at 4 hours after the onset of embolic MCA occlusion in order to suppress platelet aggregation and thereby improve the efficacy of thrombolytic therapy. Our data indicate that the combined treatment significantly improved tissue microcirculation downstream of the embolus site and reduced infarct volume.

14:08 1465. Probabilistic Prediction of Tissue Fates in Acute Ischemic Brain Injury
Qiang Shen1, Hongxia Ren1, Timothy Q. Duong1
1University of Massachusetts Medical School, Worcester, Massachusetts, USA

Tissue signatures based on perfusion and diffusion characteristics in acute stroke provide critical information on tissue fates. In this study, we propose a statistical algorithm to determine the probability and probability density of infarction on a pixel-by-pixel basis during the acute phase in a stroke rat model. Probability and probability density contours plots were derived at each time points. They were applied to predict infarction on a separate group of animals. Prediction was 83 ?7% accurate on a pixel-by-pixel basis.

14:09 1466. Mapping Cortical Projections after Stroke in Rat Brain with In Vivo Manganese-Enhanced MRI
Jet van der Zijden1, Emily Hoogveld1, Annette van der Toorn1, Ona Wu1, Rick M. Dijkhuizen1
1University Medical Center Utrecht, Utrecht, Netherlands

In this study we applied manganese-enhanced MRI (MEMRI) to map neuronal projections from the sensorimotor cortex in healthy and ischemic rat brains. The cortico-striato-nigral pathway was clearly visualized in healthy rat brains on T1-weighted images after MnCl2 injection in the sensorimotor cortex. In ischemic rat brain, signal enhancement in the substantia nigra was lost at 1-2 weeks after stroke. MEMRI provides an important tool to assess functional connectivity after brain injury.

14:10 1467. A Comparative Study of Diffusion MRI and Histology After Ischemic Stroke in Rats
Angela E. Schellenberg1, Xue-Jun Sun2, Richard J. Buist2, Marc R. Del Bigio2, James Peeling2
1University of Winnipeg, Winnipeg, Manitoba, Canada; 2University of Manitoba, Winnipeg, Manitoba, Canada

Diffusion-weighted (DW) MR imaging can be used to follow the progression of tissue injury caused by cerebral ischemia. DW and ADC images were obtained at early time points (1-6 hr) after middle cerebral artery occlusion (MCAo) in male Sprague-Dawley rats, after which the rats were killed and the brains were assessed histologically for IgG (Immunoglobulin G), MAP-2 (microtubule-associated protein-2), injured neurons (Fluoro Jade), and general features of tissue damage (Hematoxylin and Eosin). Histological evidence of tissue injury was apparent as early as 1 hr after MCAo, with a regional distribution corresponding to the observed DW abnormalities.
Acute management of stroke behooves rapid, accurate imaging techniques that evaluate dysfunction of the microvascular system within the ischemic tissue. To address this, the contrast inherent in magnetization transfer imaging (MTI) and its associated parameters were investigated and quantified as possible indices of blood-brain barrier (BBB) opening. We have described an MT tissue signature model of Kf for (apparent forward rate constant) vs. T1Sat to simplify and facilitate rapid characterization of ischemic tissue. The characteristic quantitative T1sat changes observed in vivo accurately and non-invasively detect the sites and degree of BBB opening and also identify ischemia-injured tissue with normal barrier function.

Reperfusion when induced in animal models of middle cerebral artery occlusion (MCAO) commonly differs quite markedly from that in human stroke. Upon the removal of the occluding device or suture, the restoration of blood flow takes place abruptly rather than as a gradual ‘re circulation’. In humans with spontaneous or thrombolytic-induced reperfusion following stroke, recanalisation rates of 1-3 days are common. We have used a recently developed remote-controlled rat MCAO model which produces ischaemia in the ipsilateral cortex only, to study 2 types of reperfusion; full and partial, with multiparametric MRI in acute experiments.

Four-blood vessel occlusion (4BVO) model has been used to study the cerebral hemodynamic and metabolic features linking to ischemia. However, the temporal and spatial characteristics of these features have not been well investigated, especially during early reperfusion. In this study, we applied multiparameter gradient-echo MRI and MION MRI for obtaining high temporal and spatial BOLD and CBV images during the occlusion and reperfusion. We observed that the hemodynamic responses in hippocampus, in particular in Cornu Ammonis 1 region (CA1), are significantly different from other cerebral regions. This suggests that the damage caused by ischemic insult is heterogeneous in different brain regions.

Serial manganese-enhanced MRI was used to track brain activity in subacute and chronic stroke in rats. In 4 rats, MnCl2 was injected into the cisterna magna 12 hours prior to stroke induced by 60 minutes of middle cerebral artery occlusion. Relaxation rates were mapped using EPI at 4.7T, for up to 8 days. Normal brain showed a steady increase in R1 up to 3 days post stroke induction, with a slow decline thereafter. In ischemic regions R1 dropped slightly immediately after reperfusion, remained constant for 2 days, and then slowly increased, converging with the normal brain curves by 8 days.

Recovery from cerebral hypoxia-ischemia may be related to the maturity of the brain. Recovery was assessed following cerebral hypoxia-ischemia in 1- or 4-week old rats using behavioural testing and functional MRI imaging and histology to examine cell proliferation. Behavioural recovery differed between age groups but there was no major difference in the activation response to electrical stimulation of the forepaw detected with fMRI. The greater improved functional recovery in immature brain may be related to an involvement of other pathways as suggested by greater overall cell proliferation in the subventricular granular zone occurring in 1-week compared to 4-week old rats.

We propose a new method for the quantitative calibration of BOLD signal and dHb level. Specifically, if all Hb were washed out of vessels in the localized brain region without any systemic physiological changes, the MR signal would be independent of the distribution of dHb. We report initial results using this hemodilution model for calibration of the BOLD signal under a wide range of conditions and show that the temporal dynamics of the BOLD response can vary significantly across brain regions. These differences in vascular response may have a significant impact on understanding BOLD activation in cortical and subcortical structures.
14:17  **1474. Measurements of BOLD/CBV Ratio Show Altered Hemodynamics During Stroke Recovery in Rats**  
Young Ro Kim¹, Sung Ryung Lee¹, Ing-Jye Huang¹, Joseph Mandeville¹, Maurits van Meer³, Eng Lo³, Bruce Rosen¹  
¹MGH/NMR Center, Charlestown, Massachusetts, USA; ³MGH/Neuroprotection lab, Charlestown, Massachusetts, USA

In recent years, fMRI has been increasingly used to understand the restoration of brain functions after ischemic insults. Spatial and temporal patterns of brain plasticity and functional reorganization in cortical and subcortical regions have been documented. Since functional brain activation with fMRI relies on coupling between neuronal activity and vascular reactivity, it is important to assess whether different MRI reporters of functional restoration (e.g., BOLD signal versus CBV) produce equivalent information, or whether flow-metabolism coupling is altered during the recovery period following an ischemic insult.

14:18  **1475. Formalin Fixation Alters Water Diffusion Magnitude But Not Anisotropy in Infarcted Brain**  
Shu-Wei Sun¹, Jeffrey J. Neil¹, Sheng-Kwei Song¹  
¹Washington University, St. Louis, Missouri, USA

The purpose of this study is to compare DTI parameters measured in vivo and ex vivo (following formalin fixation) mouse brain after stroke. The data show that the decrease in Tr(D) associated with stroke in vivo is not preserved after tissue fixation. In contrast, measures of diffusion anisotropy are preserved after formalin fixation, even after stroke. This suggests that the use of DTI in fixed tissues is justified, even in the presence of ischemic injury.

14:19  **1476. Mismatch between the Apparent Diffusion Coefficient of Water and Manganese Accumulation on Manganese-Enhanced MRI (MEMRI) in Experimental Focal Ischemia**  
Yasuo Inoue¹, Yuki Mori¹, Ichio Aoki¹, Chuzo Tanaka¹, Toshikiko Ebis¹, Yasuhiro Osako¹, Takashi Houri¹  
¹Kyoto Prefectural University of Medicine, Kyoto, Japan; ¹Meiji University of Oriental Medicine, Hiyoshi-cho, Funai-gun, Kyoto, Japan; ¹Nantan General Hospital, Yagi-cho, Funai-gun, Kyoto, Japan; ¹National Maizuru Hospital, Maizuru, Kyoto, Japan

The goal of this study was to test the hypothesis that mismatch between the decreased ADC and manganese accumulation on manganese-enhanced MRI (MEMRI) is observed in the superacute stage of experimental focal ischemia. Embolic ischemia in a magnet bore was remotely produced using macrospheres in 10 rats. Diffusion-weighted MRI and MEMRI were performed. The ADC in the ipsilateral caudate and cortex was significantly decreased after embolic stroke. In contrast, the manganese-enhancing region was much smaller than the area with decreased ADC, indicating the presence of mismatch between decreased ADC and manganese accumulation.

14:20  **1477. Sodium MRI after Focal Cerebral Ischemia Shows that the Presence of Collateral Circulation Does Not Affect the Accumulation of Brain Tissue Sodium, [Na⁺]**  
Stephen C. Jones², Boris Yanovski¹, Alexander Kharlamov¹, D. Kyle Kim³, George LaVerde¹, Fernando Bouda¹  
²Allegheny Singer Research Institute, Pittsburgh, Pennsylvania, USA; ³Allegheny General Hospital, Pittsburgh, Pennsylvania, USA; ¹University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Brain [Na⁺] has been proposed to assess insult duration in evolving stroke. Stroke location and the type of local blood supply may modify this relation. We used sodium MRI to test the hypothesis that the time course of [Na⁺] in cortical stroke, where collateral circulation is present, is different from that in caudoputamen stroke, where collateral circulation is absent. We showed in four animals that the rate of [Na⁺] in caudate putamen and cortex are similar. We suspect that the residual flow in the ischemic caudate putamen was responsible for the similarity in the rate of [Na⁺] increase.

Patient-Based Neuro MR Spectroscopy  
Room 157  Tuesday 13:30 - 15:30

13:30  **1478. Proton MR Spectroscopic Characterization of Alzheimer’s Disease, Fronto-Temporal Type of Dementia and Progressive Supranuclear Palsy by a 3.0 Tesla System**  
Masahito Mihrara¹, Noriaki Hattori², Kazuo Abe³, Masahiro Umeda³, Noriko Inoue³, Yoshiaki Someya³, Mieko Matsui³, Saburo Sakoda¹, Tooru Sawada²  
¹Osaka University Graduate School of Medicine, Suita, Osaka, Japan; ²BF Research Institute, Suita, Osaka, Japan; ³Meiji University of Oriental Medicine, Hiyoshi-cho, Funai-gun, Kyoto, Japan

By using 3.0 Tesla ¹H-MRS, we tried to demonstrate disease specific metabolites changes in the brain of the patients with degenerative dementias including Alzheimer’s disease (AD) and in the frontal lobes of patients with fronto-temporal type of dementia (FTD) or progressive supranuclear palsy (PSP). Single voxel ¹H-MRS data were acquired from four 8cm³ VOIs in three dementia groups and healthy volunteer group. Decreased NAA/Cr ratios were shown in all three dementia groups. While increased ml/Cr ratios were shown only in the patients with FTD, which may be characteristic and useful in differential diagnosis.
13:31  1479.  **3D Proton Spectroscopy of Gray Matter Nuclei in Relapsing Remitting MS**

Matilde Inglese¹, Songtao Liu¹, James S. Babb², Robert I. Grossman¹, Oded Gonen¹

¹New York University, New York, New York, USA

The metabolic changes in the deep gray matter (GM) nuclei of relapsing remitting (RR) multiple sclerosis (MS) patients have been investigated with quantitative, multivoxel, proton magnetic resonance spectroscopy (1H-MRS), a useful tool for studying bilaterally several structures in one session at sub-cm³ spatial resolution. The results from 11 RR MS patients showed that compared with 9 matched controls, the patients’ deep GM had 7% lower N-acetylaspartate (NAA) and 14% higher choline (Cho) concentrations (p=0.02 for both).

13:32  1480.  **Alcoholic Patients That Remain Abstinent for More Than 3 Months Show Larger Spectroscopic and Morphologic Abnormalities Than Relapsing Patients at the Beginning of Withdrawal**

Gabriele Ende¹, Helga Welzel¹, Sigrid Walter¹, Hans Herre¹, Alexander Diehl¹, Karl Mann¹

¹Central Institute of Mental Health, Mannheim, Germany

This study focuses on metabolic and volumetric brain alterations in alcoholics at the beginning of withdrawal in comparison to healthy controls. We found that the abstinent patients but not the relapsing patients had significantly lower levels of cerebellar choline-containing compounds and whole brain gray matter than healthy controls. They also had a significantly longer history of alcohol dependence than relapsing patients. Our results give evidence that alcoholic patients with increased severity of cerebellar metabolic and whole brain volumetric changes and longer duration of alcohol dependence are more likely to remain abstinent.

13:33  1481.  **A Proton MRS Study of Hippocampal Impairment in Gulf War Syndrome**

Parekkat Mohananrshiman Menon¹, Henry A. Nasrallah¹, Roy R. Reeves¹, Jeffrey A. Ali¹

¹University of Mississippi Medical Center, Jackson, Mississippi, USA; ²University of Cincinnati Medical Center, Cincinnati, Ohio, USA

Chronic fatigue and/or the effects of exposure to exogenous toxic agents may play a causative role in the Gulf War Syndrome (GWS). Single voxel in vivo proton MRS studies of the left and the right hippocampi of twenty one veterans (ten with GFS) were carried out to examine if the hippocampal function is impaired in GWS. The ratio was lower for GWS-veterans (patients) than control veterans. Younger veterans (all with Gulf War service) had a lower NAA/creatine ratio than the older veterans (> 50% Vietnam-era). These findings indicate axonal/neuronal damage and/or loss and suggest a hippocampal dysfunction in GWS.

13:34  1482.  **Brain ³¹P-MRS at 4.0 Tesla: Effects of Triacetyluridine (TAU) in the Treatment of Mood Disorders**

John Eric Jensen¹, Fuyuki Hirashima¹, Bruce M. Cohen¹, Andrew L. Stoll¹, Blaise deB. Frederic¹, Perry F. Renshaw¹

¹McLean Hospital, Belmont, Massachusetts, USA

Patients with major depression and bipolar disorder were treated with oral doses of Triacetyluridine(TAU) and underwent phosphorus MRSI scans, which were conducted immediately pre and 6 weeks post-treatment with TAU. B-NTP and total NTP levels were reduced in the right frontal-cortex in all subjects post-treatment compared to baseline. PCr/B-NTP ratio was increased in this region after treatment. Total NTP was reduced in the left-temporal lobe.

13:35  1483.  **CSF-Corrected NAA Levels Are Decreased in the Anterior Cingulate of Elderly Schizophrenic Patients**

Gabriele Ende¹, Andrea Schmitt¹, Sigrid Walter¹, Fritz A. Henn¹

¹Central Institute of Mental Health, Mannheim, Germany

We performed a MRSI study of the anterior cingulate gyrus in 28 elderly chronic schizophrenic patients under stable medication and 21 age-matched controls. Voxels chosen from patients had less GM and more WM. Nevertheless, no significant correlation of GM or WM with any metabolite value could be found. Statistical analysis revealed significantly reduced NAA values with and without CSF correction. No differences were found for signals from choline-containing-compounds and creatine/phosphocreatine. We could corroborate our previous findings of decreased NAA in the anterior cingulate of chronic schizophrenic patients in a cohort of elderly patients with a long illness duration.

13:36  1484.  **Niacin Insensitivity is Related to ¹H MRS Abnormalities in Drug-Naive First Episode Psychosis**

Stephen J. Wood¹, Gregor Berger¹, Mirabel McConchie¹, R Mark Wellard¹, Dennis Velakoulis¹, Patrick D. McGorry¹, Graeme Jackson¹

¹University of Melbourne, Melbourne, Victoria, Australia; ²Brain Research Institute, Melbourne, Victoria, Australia

While some studies have shown spectroscopic changes in first episode psychosis, this is not consistent. One potential reason for this is heterogeneity of the patient group in terms of lipid biology. We measured lipid biology using a topical niacin flush test in 20 drug naïve patients with psychosis, and showed that those who were insensitive to niacin had elevated levels of creatine and glutathione. These data indicate that altered lipid biology is a feature of some patients with psychosis.
**Comparison of Glutathione (GSH) Concentrations Quantified with STEAM versus Edited Spectroscopy: Application to Schizophrenia.**

M. Terpstra\(^1\), S. C. Schulz\(^1\), J. T. Vaughan\(^1\), K. Ugurbil\(^1\), K. O. Lim\(^1\), R. Gruetter\(^1\)

\(^1\)University of Minnesota, Minneapolis, Minnesota, USA

Glutathione (GSH) is challenging to quantify from short-echo-time 1H NMR spectra, since none of the GSH resonances are well resolved at 4T. This study was designed to compare the GSH concentrations measured using STEAM versus edited spectroscopy in a clinically relevant volume of interest. The GSH concentration measured using STEAM was 1.5 ± 0.1 (m ± SD, n=5), and that using editing was 1.3 ± 0.2 (m±SD, n=5). We conclude that reliable quantification of GSH is possible using volume coils and short echo time spectroscopy at high fields, provided spectral resolution is adequate.

**Human Brain MR Spectroscopy: Other**

**Rise in Frontal White Matter Choline is Correlated with Reversing Atrophy in Detoxifying Alcoholic Patients**

Gabriele Ende\(^1\), Helga Welzel\(^1\), Sigrid Walter\(^1\), Traute Demirakca\(^1\), Alexander Diehl\(^1\), Karl Mann\(^1\)

\(^1\)Central Institute of Mental Health, Mannheim, Germany

We hypothesized that the previously observed increase of choline-containing compounds in abstinent alcoholic patients is correlated with increased white and gray matter and a decreased amount of CSF. We found significant correlations of volumetric brain changes with frontal lobe WM Ch changes after 3 months of detoxification. The differences between the two measurements at the beginning and after 3 months of withdrawal were significant for the patients compared to controls, but as expected – in a post hoc analysis only the abstinent patients showed significantly larger differences of the volumetric and spectroscopic measures compared to healthy controls.

**Brain Metabolites and Neurocognition During Recovery From Alcoholism: A Short-TE Multi-Slice 1H MRSI Study**

Timothy Craig Durazzo\(^1\), Stefan Gazdzinski\(^1\), Dieter Johannes Meyerhoff\(^2\)

\(^1\)DVA Medical Center, San Francisco, California, USA; \(^2\)University of California, San Francisco, California, USA

Short-TE 1H MRSI and neurocognitive testing was conducted in 25 alcoholics in treatment to evaluate markers of neural and glial integrity, neurocognitive function, and their relationship during short and long-term abstinence from alcohol. Abnormally low concentrations of NAA and choline were observed in multiple brain regions during early recovery. Cho but not NAA recovered over 6-9 months of sobriety. Concentrations of neural and glial markers correlated with neurocognitive function during short-term abstinence. Longitudinal short-TE 1H MRSI allows monitoring metabolite changes throughout the brain, and illuminates mechanisms potentially involved in recovery from alcoholism.

**Utilizing 1H MRS to Examining the Relationship between SIV Encephalitis and Neuronal Injury.**

Margaret R. Lentz\(^1\), Sarah Pikenton\(^1\), Susan V. Westmoreland\(^1\), John P. Kim\(^1\), Jane B. Greco\(^1\), Eva M. Ratai\(^1\), Robert A. Fuller\(^1\), Julian He\(^1\), Prabhat Sehgal\(^1\), Andrew A. Lackner\(^1\), R Gilberto Gonzalez\(^1\)

\(^1\)Harvard Medical School/Massachusetts General Hospital, Charlestown, Massachusetts, USA; \(^2\)New England Regional Primate Center, Southborough, Massachusetts, USA; \(^3\)New England Regional Primate Center, Charlestown, Massachusetts, USA; \(^4\)Tulane National Primate Research Center, Covington, Louisiana, USA

The intention was to established whether encephalitis caused by SIV is essential for neuronal injury using the macaque model of neuroAIDS. 1H MRS was utilized to analyze brain extracts from three cohorts of macaques; those with SIVE, those chronically infected with SIV lacking encephalitis, and controls. Furthermore, we subdivided the SIVE category into mild, moderate, and severe encephalitis. Findings indicate that while there is neuronal injury in macaques with and without SIVE, differences can be seen with respect to the severity of the encephalitis. Classically defined severe encephalitis was accompanied by the greatest decrease in NAA/Cr and other neurotransmitters.

**In Vivo MR- Spectroscopy Demonstrates Reversal of Neuronal Injury with Antiretroviral Therapy in an SIV Model of neuroAIDS**

Eva-Maria Ratai\(^1\), Susan V. Westmoreland\(^2\), Margaret R. Lentz\(^1\), Jane B. Greco\(^1\), Robert A. Fuller\(^1\), John P. Kim\(^1\), Julian He\(^1\), Prabhat K. Sehgal\(^1\), Woong-Ki Kim\(^3\), Kenneth C. Williams\(^3\), Ramon Gilberto Gonzalez\(^1\)

\(^1\)Massachusetts General Hospital, Charlestown, Massachusetts, USA; \(^2\)New England Primate Research Center, Southborough, Massachusetts, USA; \(^3\)Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

To elucidate the pathogenesis of HIV-associated central nervous system injury, we utilized proton magnetic resonance spectroscopy (1H MRS) in an accelerated animal model of neuroAIDS. Rhesus macaques were infected with SIV and subsequently CD8+ lymphocyte depleted. All animals developed severe encephalitis. Using MRS we have observed substantial, consistent, cumulative decreases in the neuronal marker NAA/Cr in the frontal cortex. To examine the potential reversibility of neuronal injury, a study was performed in which infected, CD8+ depleted macaques were treated daily with antiretrovirals four weeks post infection. After therapy initiation, the levels of NAA/Cr improved dramatically.
13:34 **1490. Brain $^{31}$P-MRS at 4.0 Tesla: Methadone-Maintenance Therapy for Opiate Addiction**

John Eric Jensen¹, Crystal Mileti², Tanya Barros¹, Debye Yurgelun-Todd², Marc J. Kaufman¹, Perry F. Renshaw³, Mark Pollack⁴

¹McLean Hospital, Belmont, Massachusetts, USA; ²Massachusetts General Hospital, Boston, Massachusetts, USA

Phosphorus MRSI was used to examine brain abnormalities in opiate-dependent subjects in methadone-maintenance treatment (MMT). Two cohorts were assessed, new intakes and a second group stabilized in treatment for 2 years, that served as a comparison group. Higher NTP levels were seen in the right and left frontal-lobes of the new intake MMT group as well as higher b-NTP levels in the right frontal-lobe in the new intake group, compared to the 2 year MMT treatment group. Total NTP levels were elevated in a sub-cohort of the new intake group after 2 months of MMT compared to baseline levels.

13:35 **1491. Effective Transverse Relaxation Time of the C4 Proton Multiplet Resonance of Glutamate in Tissue Phantoms and Human Brain at 3 Tesla**

Florian Schubert¹, Barbara Lahnor¹, Frank Seifert¹, Herbert Rinneberg¹

¹Physikalisch-Technische Bundesanstalt, Berlin, Germany

Since at higher B0 longer echo times appear promising for MR-spectroscopic determination of L-glutamate, T2 of the target resonance is required for quantification. As the spectral pattern of multiplets depends on TE, referencing of in vivo spectra to phantom spectra acquired at the same set of TE yields an effective T2. We determined the effective T2 of the glutamate-C4 at 3 Tesla in two cortical voxels and a brain-mimicking phantom. The values are suitable for determination of glutamate concentrations provided a phantom spectrum acquired at the same echo time as the in vivo spectrum is used for spectral fitting.

**MR Imaging of Multiple Sclerosis**

Room 157    Thursday 13:30 - 15:30


Dominique M.J. Van den Heuvel¹, Ad C.G.M. van Es¹, V. Hester ten Dam¹, W. Miguel Palm¹, Faiza Admiraal-Behloul¹, Aart Spilt¹, Gerard Jan Blauw¹, Eduard L.E.M. Bollen¹, Rudi G.J. Westendorp¹, Mark A. van Buchem¹

¹Leiden University Medical Center, Leiden, Netherlands

Visual rating scales aimed at estimating the load of white matter lesions (WML) in the brain are subjective, which may limit their use in longitudinal studies. In this study we compared a widely used visual rating scale with a quantitative volumetric method to assess WML in a longitudinal study. Our results demonstrate that quantitative volumetric assessment of WML load is more objective, reliable and exact and therefore this method seems to be superior for assessment of longitudinal WM changes.

13:31 **1493. Regional Brain Atrophy Evolves Differently In MS Patients According to Their Clinical Phenotypes**

Elisabetta Pagani¹, Maria A. Rocco¹, Antonio Gallo¹, Vittorio Martinelli¹, Mariemma Rodegher¹, Giancarlo Comi¹, Massimo Filippi¹

¹Ospedale San Raffaele, Milan, Italy

We studied 70 multiple sclerosis (MS) patients using the Structural Image Evaluation using Normalization of Atrophy (SIENA) software and voxel-based morphometry analysis to spatially characterize the evolution of brain atrophy in different disease phenotypes. While ventricular enlargement was predominant in the relapsing forms, cortical atrophy was found to be the major feature of the progressive forms of MS. In addition, measures of regional brain atrophy correlated significantly with disability, suggesting that the application of such an approach to the study of MS patients is a promising tool to bridge the gap between clinical and MRI findings in MS.


Gerard Robert Davies¹, Dan Altmann¹, Waqar Rashid¹, Colette Griffin¹, Declan Chard¹, Paul Tofts¹, Gareth Barker¹, David Miller¹

¹Institute of Neurology, London, UK

Twenty three minimally disabled, early relapsing-remitting multiple sclerosis (MS) patients and 19 healthy controls were imaged yearly for two years using magnetization transfer (MT) imaging. Global but tissue-specific normal-appearing white matter (NAWM) MT ratio (MTR) was determined and change over time was assessed using a hierarchical regression model. Mean NAWM MTR was significantly lower in MS patients at baseline and there was a significant decline in MTR over time in MS patients compared with controls. Backward extrapolation of the gradient of change suggests that NAWM abnormality was present 5.2 years prior to clinical onset, assuming linearity in time.
13:33 1495. Correlation of the Bound Proton and Myelin Water Fractions from Quantitative Magnetisation Transfer and Multi-Exponential $T_2$ Analysis in Normal and Multiple Sclerosis Brain

Daniel Tozer$^1$, Gerard R. Davies$^1$, David H. Miller$^1$, Paul S. Tofts$^1$

Institute of Neurology, University College London, London, UK

Quantitative magnetisation transfer and multi-exponential $T_2$ analysis are techniques for looking at the structure of tissue. Both provide a measure which purports to be related to the myelin within a tissue, namely the bound proton and myelin water fractions. This work investigates whether these two measures are correlated in normal and Multiple Sclerosis affected brain tissues to determine whether they provide complimentary information. Both imaging techniques were performed and it was established that while no single tissue type shows a correlation between the two fractions, looking at all tissues pooled showed a significant correlation ($p<0.001$) between them.

13:34 1496. Early and Progressive Increase in Transverse Diffusion in White Matter Fiber Tracts of Patients at Risk for Multiple Sclerosis

Roland G. Henry$^1$, Meredith Metcalf$^1$, Jeffrey I. Berman$^1$, Daniel Pelletier$^1$

University of California, San Francisco, San Francisco, California, USA

Previous analysis of normal appearing tissue in Relapsing-Remitting Multiple Sclerosis (RRMS) patients with diffusion tensor MRI (DT-MRI) indicated increased diffusion transverse to white matter tracts with no change in diffusion along the tracks, a signature consistent with Wallerian degeneration. DT-MRI of patients at risk for RRMS were investigated to determine the earliest changes in normal appearing tissue. Serial studies of these patients at 3-month intervals revealed the same pattern of change in diffusion as previously observed in RRMS patients at 6 months and continuing till 12 months and may reflect the earliest manifestations of tract degeneration.

13:35 1497. Patterns of Brain Damage in Patients at Presentation With Clinically Isolated Syndromes Suggestive of MS: A Multiparametric MR Study

Antonio Gallo$^1$, Marco Rovaris$^1$, Anna Gambini$^1$, Andrea Falini$^1$, Beatrice Benedetti$^1$, Roberto Riva$^1$, Angelo Ghezzi$^2$, Vittorio Martinelli$^2$, Giuseppe Scotti$^2$, Giancarlo Comi$^2$, Massimo Filippi$^2$

Ospedale San Raffaele, Milan, Italy; Ospedale di Gallarate, Gallarate, Italy

In 46 patients with clinically isolated syndrome (CIS) suggestive of multiple sclerosis (MS), we obtained conventional, diffusion tensor (DT) MRI of the brain and 1H-MRS to measure whole brain N-acetylaspartate (WBNAÁ) concentration. Mean diffusivity (MD) and fractional anisotropy (FA) histograms of normal-appearing gray (NAGM) and white matter (NAWM) were produced. When compared to healthy controls, patients showed an increase of NAWM MD ($p<0.01$), a decrease of NAWM FA ($p<0.001$) and a reduction of average WBNAÁ concentration ($p<0.001$). NAWM damage associated with axonal loss/dysfunction occurs at a very early stage in patients at presentation with CIS suggestive of MS.

13:36 1498. Are Regional Fractional Anisotropy Values Better Surrogates than Conventional MR Measures in Multiple Sclerosis?

Khader M. Hasan$^1$, Bhavik P. Kanabar$^2$, Rafeal M. Santos$^1$, Jerry S. Wolinsky$^2$, Ponnada A. Narayana$^1$

University of Texas, Houston, Texas, USA; UH, Houston, Texas, USA

Whole brain diffusion tensor imaging, multi-echo, and Gd-enhanced MRI data were acquired on a cohort of 30 clinically definite multiple sclerosis subjects and 15 age matched controls. Fractional anisotropy values of seven functionally distinct regions in corpus callosum and posterior limb of internal capsule were correlated with extended disability status score, disease duration, total brain lesion load, and black hole volume. Our analysis implicates the anterior midbody of the corpus callosum and the internal capsule in this patient population. The results obtained are consistent with previously published histological studies on MS, but not with the published DTI results.

13:37 1499. Short-Term Evolution of Brain Tissue Damage in Patients With Progressive Multiple Sclerosis: An in Vivo Study Using Diffusion Tensor MRI

Marco Rovaris$^1$, Antonio Gallo$^1$, Domenico Caputo$^1$, Enrico Montanari$^1$, Angelo Ghezzi$^1$, Beatrice Benedetti$^1$, Maria P. Sormani$^1$, Antonio Bertolotto$^1$, Gianluigi Mancardi$^1$, Roberto Bergamaschi$^1$, Vittorio Martinelli$^1$, Giancarlo Comi$^1$, Massimo Filippi$^1$

Ospedale San Raffaele, Milan, Italy; Institute Don Gnocchi, Milan, Italy; Ospedale di Fidenza, Fidenza, Italy; Ospedale di Gallarate, Gallarate, Italy; Ospedale di Orbassano, Orbassano, Italy; University of Genoa, Genoa, Italy; Institute C. Mondino, Pavia, Italy

Fifty-four patients with primary progressive (PP) and 22 patients with secondary progressive (SP) multiple sclerosis (MS) underwent conventional and diffusion tensor (DT) MRI of the brain at baseline and after a mean follow-up of 15 months. In both patient groups, the average brain T2 and T1 lesion volume did not change significantly over the study period, whereas a significant increase of the average normal-appearing grey matter (NAGM) diffusivity, as well as a significant decrease of average NAGM fractional anisotropy were found at follow-up. None of the changes significantly differed between the subgroups of patients with and without clinical worsening.
Texture change during the evolution of an MS lesion, from normal appearing white matter (NAWM) to an active, then an inactive lesion, was quantified from 1.5T T2-weighted MRI using a novel local multiscale Fourier analysis technique: the polar S transform (PST). The spectral distribution changed markedly during MS lesion development. There were large, statistically significant, differences in the local low spatial frequencies between NAWM, active lesions, and inactive lesions. This study suggests that the PST may provide a quantitative measure of lesion activity in T2w MRI, and help evaluate treatment effects in MS clinical trials.

Abnormally decreased signal intensity of deep gray matter on T2-weighted MRI (black T2) in patients with multiple sclerosis has been investigated in 1.5 T MR exams. It was found to be associated with other MR-based measures and to be a strong predictor of disability and clinical course. In the context of increasing use of 3.0 T MRI, we investigated the appearance of black T2 at 3.0 T. Preliminary results demonstrated different characteristics of black T2 at 3.0 T. Our results suggest that 3.0 T MRI provides more sensitive detection of iron deposition in deep gray matter than 1.5 T.

High resolution magnetic resonance imaging at 8 Tesla (T) is used to visualize multiple sclerosis (MS) lesions in the cortical gray matter. Both gradient echo and spin echo images with 100-200 micron resolution are acquired from whole brain slices. These post mortem brain samples are fixed in formalin and imaged at 8T. These results will help with the development of techniques for imaging at ultra high field of MS patients with the possibility of visualizing such lesions within clinically acceptable time.

Developmental venous anomalies (DVA) are the most common intracranial vascular lesions detected by MRI or CT. 700 adult patients with clinically definite or laboratory supported multiple sclerosis (MS) were studied. Eighty of 700 (12.6%) MS patients had a total of 97 DVA. Seventy patients had single DVA and 9 patients had two or more DVA. Eighty-four DVA were supratentorial and 13 were infratentorial. Compared with 1.2 – 2.5% of DVA finding in clinical examinations, our results indicate that DVA to be more common in patients with MS (12.6%).

MR imaging and MRI-derived measurements play an indispensable role in the diagnosis and monitoring of multiple sclerosis. The B1 inhomogeneity may result in severe signal intensity inhomogeneity that can significantly interfere with image interpretation and MRI-derived measurements. With the increasing use of 3.0 T MRI in clinical settings and drug trials, we investigated the dielectric effect artifact appearing on brain images of MS patients scanned at 3.0 T. We also developed a new image nonuniformity correction algorithm that satisfactorily corrects the artifacts at a very fast speed.
**MR Spectroscopy of Multiple Sclerosis**

Room 157  Thursday 13:30 - 15:30

13:30  **1505. Differentiation of Acute and Subacute Demyelinating Lesions with Short Echo Time Chemical Shift Imaging**
Jan Ruff¹, Florian Mehnert², Thomas Naegle³, Wilhelm Kueker³, Stefan Roell¹, Uwe Klose¹
¹Siemens Medical Solutions, Erlangen, Germany; ²University of Tuebingen, Tuebingen, Germany

A patient with acute and subacute demyelinating lesion was investigated with MRI and MRS on a Siemens Avanto 1.5T system equipped with a 12 channel CP head array coil. Standard MRI techniques (FLAIR, T1, T2, T1 with CM) revealed one bright lesion and could not differentiate between the active and subacute demyelination. Chemical Shift Imaging (CSI) especially short echo time CSI on the other hand is able to differentiate between the active and subacute demyelinating lesions regarding N-acetyl-aspartate (NAA), myo-Inositol and lipid/macromolecule signals.

Matilde Inglese¹, Belinda SY Li¹, James S. Babb¹, Robert I. Grossman¹, Oded Gonen¹
¹New York University, New York, New York, USA

To quantify the metabolic characteristics of NAWM and non-enhancing lesions, 9 MS patients underwent MRI and 3D 1H-MRS. Absolute NAA, Cr and Cho levels were obtained from 171 voxels: 66 in T2WI lesions (43 hype, 23 iso-intense on T1WI), 31 in NAWM, and 74 from controls’ NWM. In hypo-intense lesions, NAA was lower than in iso-intense, NAWM and NWM. In iso-intense lesions, Cho and Cr were indistinguishable from NAWM but 20% and 24%, higher than the NWM. NAA level was also 14% lower than the NWM’s. Despite absence of Gd-enhancement, abnormal metabolic activity persists in all MS tissue types.

13:32  **1507. Metabolite T1 Relaxation is Preserved in Large Multiple Sclerosis Lesions**
Cornelia Laule¹, Elana E. Brief¹, Irene M. Vavasour¹, Anthony L. Traboulsee¹, David K.B. Li¹, Alex L. MacKay¹
¹University of British Columbia, Vancouver, British Columbia, Canada; ²Simon Fraser University, Vancouver, British Columbia, Canada

Magnetic resonance spectroscopy (MRS) abnormalities observed in multiple sclerosis (MS) lesions are usually attributed to metabolite concentration changes but could be affected by T1 weighting. Using PRESS (TE=30ms,TR=547,750,1200,1500,2500,3500,5000ms) spectra were collected in large lesions from 8 MS patients and T1’s of NAA, Choline, Creatine, myo-Inositol and water were estimated. No significant differences were found between metabolite T1’s of MS lesions and control white matter, however water T1 was significantly longer in lesions (p<0.0001). Therefore, although metabolite concentrations may change in lesions, the local intracellular environment stays intact and MRS data collected at shorter TR is not influenced by T1 weighting.

13:33  **1508. MRI Evidence For Primary Degeneration of Myelin and Axons in Patients with Multiple Sclerosis**
Zografos Caramanos¹, Patricia Le Nezet¹, Andre Matos¹, M. Carmela Tartaglia¹, Simon J. Francis¹, Sridar Narayananan¹, D. Louis Collins¹, Douglas L. Arnold¹
¹Montreal Neurological Institute, Montreal, Quebec, Canada

Cross-sectional study of 73 MS patients examined relationships between disease duration and abnormalities in MR surrogates of (i) NAWM myelin integrity (tissue-specific magnetisation transfer ratios), (ii) peri-ventricular axonal integrity (1H-MRSI NA/CR values), and (iii) cerebral atrophy (brain to intra-cranial capacity ratios). Found: (i) significant myelin disturbance in patients’ NAWM present even prior to disease onset that remained constant with disease duration; (ii) significant axonal disturbance was also present well before disease onset – but became even more severe with disease duration; and (iii) cerebral atrophy was not present at disease onset – but developed over the duration of the disease.

13:34  **1509. Interrelation between MR Based Surrogate Markers of Multiple Sclerosis, Disease Severity and Altered Neuroendocrinological Functioning**
Erina M. Schumann¹, Tanja Kümpl³, Timo Schirmer², Mirjana Blazevic¹, Johannes Behrends¹, Axel Wissmüller³, Claudia Trenkwalder³, Dorothee P. Auer³
¹Max-Planck-Institute of Psychiatry, Munich, Germany; ²GE Medical Systems, Halbergmoos, Germany; ³Department of Radiology, Munich, Germany; ³Paracelsus Klinik, Kassel, Germany

Hyperdrive of the hypothalamo-pituitary-adrenal (HPA) axis is associated with a chronic course of multiple sclerosis (1) and enlarged ventricles (2). To further investigate the potentially disease modulating role of neuroendocrinological malfunctioning, 26 MS patients were characterized for HPA functioning, EDSS, proton spectroscopy of the hippocampal region and parietal white matter, T2 lesion load (LL) and the brain parenchymal fraction (PBF). Spearman’s rank correlation tests revealed a significant negative association between EDSS and hippocampal NAA/Cr (rho=-0.647) and PBF (-0.475). NAA/Cr was negatively associated with T2LL (r=–0.508 white matter, -0.587 hippocampus), but not with PBF. No correlations emerged with HPA hyperdrive.
**Poster Sessions**

**MR Imaging of Head, Neck, and Spine**

**Room 157**  
**Tuesday 13:30 - 15:30**

**13:30 1510. Phase-Contrast MRI of Pulsatile Cerebrospinal Fluid Flow in Patients with Cervical Spondylitic Myelopathy.**  
*Karl V. Embleton¹, Aprajay Golash², Yvon Watson¹, Alan Jackson¹*  
¹University of Manchester, Manchester, UK; ²Royal Preston Hospital, Preston, UK

Pulsatile cerebrospinal fluid (CSF) flow was measured at three points in the cervical spine using phase-contrast MRI. Flow dynamics in 3 subject groups, cervical spondylitic myelopathy (CSM), subjective myelopathy and normals were compared. Waveforms of the flow through the cardiac cycle were extracted. Sections taken at and below stenosis level showed lower flow in patients with CSM, however no significant difference was found above stenosis. Proportional time from commencement of caudal flow to peak flow was significantly shorter in the CSM group. Similar but less significant changes were identified in patients with minimal stenosis and subjective myelopathy.

*John Anthony Butman¹, Andrea J. Rebmann¹*  
¹National Institutes of Health, Bethesda, Maryland, USA

Inhalation 100% O₂ results in large signal changes in the CSF on FLAIR imaging due to the paramagnetic effect of O₂. Using EPI-FLAIR to obtain whole brain data every 30 sec to characterize the time course, we observed two components of O₂ induced signal change. A rapid component localized to sulcal CSF adjacent to the pia, while a slower component was found in larger cisternal CSF spaces. We propose that the first component reflects the time course of alveolar ventilation and the second reflects diffusion of O₂ in the CSF.

**13:32 1512. Oxygen Enhancement of the Vitreous on FLAIR as a Marker of Retinal Oxygen Delivery**  
*John Anthony Butman¹*  
¹National Institutes of Health, Bethesda, Maryland, USA

FLAIR is sensitive to subtle alterations in the T₁ of fluid compartments, as may result from an increase in molecular oxygen due to its paramagnetic effect. Combining FLAIR imaging of the globe with inhalation of 100% oxygen results in large signal changes in the vitreous attributable to oxygen delivery to the retina and diffusion into the vitreous.

**13:33 1513. Kinematic Imaging of the Orbit: Comparison of FIESTA and FSE Images for the Evaluation of the Ocular Movement**  
*Takayuki Masui¹, Motoyuki Katayama¹, Shuhei Yamashita¹, Nobuko Yoshizawa¹, Yasuhisa Nakamura¹, Masayoshi Sugimura¹, Atsushi Nozaki², Mitsuru Ikeda³, Harumi Sakahara⁴*  
¹Seirei Hamamatsu General Hospital, Hamamatsu, Shizuoka, Japan; ²GE Yokakawa Medical System, Hino, Shizuoka, Japan; ³Nagoya University Hospital, Nagoya, Aichi, Japan; ⁴Hamamatsu University School of Medicine, Hamamatsu, Shizuoka, Japan

Kinematic approach with MR imaging is useful to assess the causes of the dysfunction of the extraocular muscles. In The purpose of the study was to compare T₁-weighted FSE with FIESTA for their image quality and abilities of the detection of the dysfunction of the ocular movement using a kinematic display. 41 subjects were included for the evaluation of horizontal and vertical ocular movement. Accuracy of Kinematic FIESTA images for detection of the dysfunction of the ocular movement was the highest among the static and kinematic images although susceptibility artifacts were prominent in oblique sagittal images of FEESTA.

**13:34 1514. Application of Tagged MRI in the Study of Synergistic Actions of Lingual Muscles during Contraction Tasks**  
*Sungheon Kim¹, Cengizhan Ozturk¹, Gloria Chi-Fishman¹*  
¹National Institutes of Health, Bethesda, Maryland, USA

The purpose of this study is to determine the feasibility of using tagged MRI to study the mechanical interactions of in vivo lingual tissue during dynamic contraction tasks and to identify the muscles contributing to the synergistic execution of lingual motor activities, especially those that may effect volumetric changes in the tongue. Our preliminary results demonstrate that tagged MRI is useful in analyzing task-induced complex interactions of intrinsic and extrinsic lingual muscles and holds considerable promise for providing insights into lingual motor control.
In a well-characterized rat model of spinal cord injury we evaluated diffusion tensor and magnetization transfer MR imaging as methods for assessing the extent of a moderate contusion injury. Rats were given a moderate injury to their spinal cord at T9 and subsequently imaged over 42 days. Imaging results were correlated with 2D Kinematics and histology on euthanized animals.

Two different Magnetic Resonance Imaging methods were combined to develop a novel method for assessing the injured spinal cord. In the present work this method was developed and tested in non-injured rats. Diffusion Weighted Imaging (DWI) was used for the investigation of anisotropic water diffusion in neuronal fibers while functional Magnetic Resonance Imaging (fMRI) was used for the evaluation of neuronal activity of the spinal cord. The acquisition of combined DTI and fMRI in one scan provides complete information about the morphological and functional condition of the cord essential in the study of spinal cord injury.

The evaluation of Adrenomyeloneuropathy (AMN), a neurodegenerative disease affecting the spinal cord, is hampered by lack of sensitive markers. Global Magnetization Transfer (GMT) in which MT images are acquired over a wide frequency range, was employed to assess white matter pathology in the spine of AMN patients. Studies were conducted in ten severely affected men, ten less severely affected women and ten controls. GMT images showed signal hyperintensities in lateral and dorsal columns of all patients, which agrees with pathological studies. Mean GMT signal in the cervical dorsal column showed highly significant differences between the affected men, women and controls.

Involvement of spinal cord in primary progressive multiple sclerosis (PPMS) is an important element in disability. Since conventional imaging gives little information about the pathology of injury, innovative techniques have developed to provide more specific data. Twenty-four patients with PPMS underwent volumetric and myelin water imaging experiments at baseline, year 1 and year 2. Although there was no correlation with EDSS, a reduction in both cord area and amount of myelin associated water at C2/C3 when compared to controls at baseline, as well as over 2 years, gives evidence for more specific substrates of clinical disability and progression in PPMS.

The etiology of lower back pain, associated with disc degeneration and injury, can be modeled in animals like sheep by examining changes in the annulus fibrosus (AF) microstructure. Oriented collagen fibers give rise to bright and dark regions in the AF on an MRI, consistent with dipolar relaxation of oriented water. Sheep disc, however, is too large for diffusion tensor microscopy methods in reasonable scan times. To rapidly and non-invasively quantify collagen orientation in whole discs, therefore, we implemented a technique based on dipolar relaxation of water, and compared results from both sheep and human discs.

High resolution MRI examinations (0.4mm x 0.4mm x 0.4mm) of the inner ear structures were performed at 1.5 T and at 3 T. The completely rephased steady-state gradient echo technique 3D-CISS was applied with equivalent parameters. A quadrature detection head coil was used in both cases. Despite SAR constraints imaging at 3 T resulted in higher SNR. A factor of 1.4 was found for the inner ear structures and 1.6 for the region of the cerebellopontine angle.

Poster Sessions
13:41  **1521. Apparent Diffusion Coefficient of Squamous Cell Carcinomas and Malignant Lymphomas in Head and Neck**

Masayuki Maeda¹, Hajime Sakuma¹, Stephan E. Maier², Kan Takeda¹

¹Mie University School of Medicine, Tsu, Japan; ²Brigham and Women's hospital, Boston, Massachusetts, USA

The aim was to determine whether apparent diffusion coefficient (ADC) can differentiate between squamous cell carcinomas (SCC) and malignant lymphomas (ML) in head and neck regions by line scan diffusion-weighted imaging (LSDWI). LSDWI was performed in 38 SCC and 14 ML. Images were obtained with a b factor of 5 and 1000 s/mm². The mean ADC was 0.96 ± 0.11 x 10⁻³ mm²/s in SCC, and 0.65 ± 0.09 x 10⁻³ mm²/s in ML. There was a significant difference between the two (p< 0.01). The ADC may be useful for differentiating between SCC and ML.


Ravinder R. Regatte¹, Sarma VS Akella¹, Ravinder Reddy¹

¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

The purpose of the work was to investigate the residual dipolar interaction in bovine intervertebral disc specimens employing the spin-lattice relaxation time in the rotating frame. In spin-locked spectroscopic experiments we observed bi-exponential relaxation of water. The initial, fast decaying components have damped dipolar oscillations. In an isolated annulus fibrosus (AF) and nucleus pulposus (NP), the fast decay times are 15ms and 74ms respectively at γB₁ of 250Hz. Rapidly damped oscillations observed in AF seem to be related to tissue micro-architecture of collagen fibers and have potential to quantify the structural integrity of the disc.

13:43  **1523. 3.0T Contrast-Enhanced, Submillimeter MRA of the Supraaortic Arteries: Does the Signal Gain at High Field Strength Allow to Replace the Phased Array Coil by the Quadrature Body Coil?**

Winfried A. Willinek¹, Juergen Gieseke¹, Marcus von Falkenhausen¹, Mark Born¹, Romhild Hoogeveen¹, Thomas Bayer¹, Horst Urbach¹, Christiane K. Kuhl¹, Hans H. Schilde²

¹University of Bonn, Bonn, Germany; ²PMS, Best, Netherlands

Purpose of the study was to evaluate contrast-enhanced MR angiography (CE MRA) of the supraaortic arteries at 3.0T using the quadrature body coil as transmitter and receiver. CE MRA was performed with randomly segmented central k-space ordering in 43 patients and 5 volunteers using a 350 mm FOV and a high image matrix of 432 x 432 (measured voxel: 0.66 mm³).Our experience showed that submillimeter CE MRA of the supraaortic arteries is feasible at 3.0T by using the quadrature body coil. The large FOV allowed to cover the supraaortic arteries from the aortic arch up to the circle of Willis.

13:44  **1524. The Auditory Neural Pathway Evaluation on Middle Ear Lesions Using Diffusion Tensor Imaging**

Yongmin Chang¹, Sang-Hun Lee¹, Young-Joo Lee¹, Jae-Joon Lee¹, In-Sung Kim¹, Sung-Jin Bae¹, Sung-Gu Woo², Hee-Jung Lee²

¹Kyungpook National University, Daegu, Korea, Republic of Korea; ²Keimyung University, Daegu, Korea, Republic of Korea

The middle ear lesions induce either conductive or sensorineural hearing loss. In this study, we investigate the functional change of auditory pathway in patients of middle ear lesion and evaluate the difference in auditory tract integrity between conductive and sensorineural hearing loss among patients with middle ear lesion using DTI.

13:45  **1525. Diffusion-Weighted Imaging of the Parotid Gland: Influence of the Choice of b-Values on the Apparent Diffusion Coefficient (ADC) Value.**

Harriet C. Thoeny¹, Frederik De Keyzer², Robert Hermans¹, Chris Boesch²

¹University Hospitals Leuven, Leuven, Belgium; ²University & Inselspital Berne, Berne, Switzerland

Considerable discrepancies in the ADC values of the salivary glands in healthy volunteers are found amongst published reports. ADC values calculated from low b-value settings were significantly higher then those from high b-value settings. These results suggest that not only true diffusion but also perfusion contributes to the ADC. Attention has to be paid when interpreting the ADC values in DW – EPI of the salivary glands: by a varying contribution of molecular diffusion and tissue perfusion, the ADC values are influenced by the chosen b-values.

13:46  **1526. Flow Vector Field and Streamline Visualization of Hemodynamics near Carotid Plaque- A High Field 3T Study**

Sinyeob Ahn¹, Shantanu Sinha¹, John Grinstead¹, Sujata Jinagaouda¹, Rebecca Hua¹, Elliel Castillo¹, Mohammed F. Saad¹

¹University of California at Los Angeles, Los Angeles, California, USA

High field (3T) MR imaging of the carotid bifurcation and atherosclerotic plaque was performed in both normals and patients on a Siemens TRIO, with built-in spine array coil. TSE PDW images with dark blood, 3D TOF-MRA for the vessel imaging and phase contrast images for in- and through-plane flow quantification were acquired. Excellent visualization of the carotid and plaque was achieved both in the bright and dark blood mode. The gated PC images allowed flow quantification near the plaque and visualization by streamlines and velocity vector fields.
13:47  **1527. Validation of In Vivo MRI Lingual Volume Measurement Using Ex Vivo Models**  
1National Institutes of Health, Bethesda, Maryland, USA; 2North Carolina State University, Raleigh, North Carolina, USA; 3Oregon State University, Corvallis, Oregon, USA; 4University of Maryland School of Medicine, Baltimore, Maryland, USA

The purpose of this study was to validate a method for tongue volume measurement on 3D MRI and to assess the validity of the validation technique using inter- and intra-operator reliability measurements. To this end, we used *ex vivo* human and animal models for MR imaging and performed image-based volume measurements with cross validation against physical tongue volumes. Results showed that the *ex vivo* models adequately validated the volumetric scanning and volume measurement methods used in our *in vivo* study. Inter-operator agreement was consistently good and intra-operator variations reduced with practice. Operator training is crucial to volume measurement accuracy.

**Spine MR Imaging**

Room 157  Thursday 13:30 - 15:30

13:30  **1528. Imaging Cellular Responses in Experimental Spinal Cord Injury Using SPIO and 3DFIESTA at 1.5T**  
*Beth Dunn*, Paula J. Foster  
1Robarts Research Institute, London, Ontario, Canada

Cellular imaging with SPIO and 3DFIESTA at 1.5T was developed and applied to study the cellular inflammatory responses in spinal cord injury. Regions of signal void in FIESTA images represent iron labeled cells in the cord tissue. A cell depletion experiment was employed to help determine the source of infiltrating cells.

13:31  **1529. In Vivo and In Vitro High Field Imaging of Rat Spinal Cord Injury**  
1University of Wuerzburg, Wuerzburg, Germany; 2University of Regensburg, Regensburg, Germany

Only a very limited number of MR studies has been performed on SCI models, most of them suffering from a limited spatial resolution. In-vivo and in-vitro MR scanning was performed on a rat model of spinal cord injury. The study showed that it is possible to directly visualize spinal cord contusion injuries at a very high spatial resolution as compared to studies performed at lower field strengths. Pathological changes – like the formation of cysts - that can be represented in histological sections are also visible in MRI data both in vitro and in vivo to a limited extent.

1University of Chicago, Chicago, Illinois, USA; 2University of Florida, Gainesville, Florida, USA

Transplantation of fetal spinal cord (FSC) tissue has demonstrated significant potential in animal models for achieving partial anatomical and functional restoration following spinal cord injury (SCI). In order to test whether this strategy can eventually be translated to human patients with SCI a pilot safety and feasibility study was initiated in patients with progressive post-traumatic syringomyelia (PPTS). A key outcome measure in this investigation was repeated MRI evaluation, which has previously revealed surviving intraspinal grafts in animal models. We report here the MRI results through two years of follow up in 8 subjects.

13:33  **1531. Apparent Diffusion Coefficient and Fractional Anisotropy of Spinal Cord: Changes Related to Age and Cervical Spinal Spondylosis.**  
*Hatsuho Mamata*, Ferenc A. Jolesz*, Yutaka Imat*, Stephan E. Maiert*  
1Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; 2Tokai University School of Medicine, Isehara, Kanagawa, Japan

Diffusion-weighted tensor imaging was used to measure apparent diffusion coefficient (ADC) and fractional anisotropy (FA) in cervical spondylosis cases. Elevated ADC and decreased FA values within the spinal cord at the narrowed spinal canal level were found in majority of cases with severe spondylosis that had no abnormal signals on T2-weighted images. ADC and FA may be more sensitive measures to detect early spinal cord abnormality than signal abnormalities on T2-weighted images. Age related ADC and FA change of cervical spinal cord in normal spinal cord is also shown and discussed in this study.
13:34  
**1532. Early Involvement of the Spinal Cord in ‘Peripheral’ Diabetic Neuropathy**  
Dinesh Selvarajah1, Solomon Tesfaye1, Celia J. Emery1, Paul D. Griffiths1, Pamela Greenwood2, Nigel D. Harris1, Pamela Shaw1, Iain D. Wilkinson1  
1Royal Hallamshire Hospital, Sheffield, UK; 2University of Sheffield, Sheffield, UK

The full extent of nervous system involvement in diabetic neuropathy (DSP) remains poorly understood. Seventy-seven male, type-1 diabetic patients (27 Non-DSP, 20 SubClinical-DSP, and 30 Established-DSP) and 16 non-diabetic controls (HV) underwent cervical-spine MRI/cord cross-sectionalarea (CSA) quantitation. Mean CSAs were lower in both DSP groups compared to Non-DSP and HV (p<0.0001). 15% of SubClinical-DSP and 16% of Established-DSP had cord atrophy. SubClinical DSP had morphometric cord changes to suggest preferential spinothalamic tract involvement. In conclusion, we have demonstrated early involvement of the CNS in DSP reflected in marked reduction in cord CSA using this non-invasive, rapid diagnostic test.

13:35  
**1533. Functional Magnetic Resonance Imaging (fMRI) of the Human Cervical Spinal Cord**  
Stanislaw Kwiecinski1, Paul Summers2, Patrick Stroman3, Spyros Kollias1  
1University Hospital Zurich, Zurich, Switzerland; 2National Research Council of Canada, Winnipeg, Manitoba, Canada

We assessed the feasibility of spinal cord fMRI on a 1.5T clinical system and investigated whether the areas of activation can be related to neuroanatomic locations specific to focal upper extremity motor tasks and sensory stimulations. Images were acquired in the transverse plane covering the cervical spinal cord, from vertebrae C4 to T1. Average intensity increases of 3-5% of the f-MRI signal during activation were observed in all experiments. Most foci of activation were localized to areas expected to exhibit neuronal involvement. Further studies will focus on ascertaining the levels of reproducibility which can be achieved with spinal IMRI studies.

13:36  
**1534. Functional MRI of the Spinal Cord at Low Field**  
Kelvin K. Wong1, M C. Ng1, Yong Hu1, D K. Luk1, Q Y. Ma1, Edward S. Yang1  
1University of Hong Kong, Hong Kong

A second contrast mechanism SEEP was reported to co-exist with BOLD during fMRI activation. The mechanism was based on the task-induced signal change of extravascular water protons and was primarily shown in the spinal cord at high field. Recently, a preliminary study was reported at 0.2T showing SEEP contrast in the brain while the BOLD effect was negligible. The present study is to investigate the presence of SEEP in the spinal cord at 0.2T using proton density-weighted imaging with motor task. Bilateral activations were obtained in the anterior grey horns consistently across C6-C8 levels, which correlated with the neural anatomy.

13:37  
**1535. Mean Diffusivity and Fractional Anisotropy Histogram Analysis of the Cervical Cord in Patients With Multiple Sclerosis**  
Paola Valsasina1, Federica Agosta1, Maria A. Rocca1, Vittorio Martinelli1, Marco Rovaris1, Andrea Falini1, Giancarlo Comi1, Massimo Filippi1  
1Ospedale San Raffaele, Milan, Italy

We obtained mean diffusivity (MD) and fractional anisotropy (FA) histograms of the cervical cord from a large cohort of MS patients to investigate whether diffusion histogram-derived metrics are significantly different between controls and patients and among different MS phenotypes. We found significant differences in MD and FA histograms derived metrics between controls and all MS patients, and among different MS phenotypes. We found also significant correlation between MD and FA and clinical disability, suggesting that an accurate assessment of cervical cord damage in MS provides information that might be useful to explain the clinical manifestations of the disease.

13:38  
**1536. Ultrashort TE (UTE) Magnetic Resonance Imaging of the Spine in Thalassemia**  
Margaret A. Hall-Craggs1, John Porter1, Peter D. Gatehouse1, Graeme M. Bydder1  
1University College London, London, UK; 2Royal Brompton Hospital, London, UK; 3UCSD, San Diego, California, USA

Ultrashort TE (UTE) pulse sequences were used to examine the lower thoracic and lumbar spine in three symptomatic patients with α-thalassemia major or intermedia. Using sequences with both long T2 component and fat suppression, the patients showed hyperintense bands in the discs adjacent to their vertebral end plates. These changes were most marked in the patient with the most severe disease. In the patient with least disease, findings were present in discs which did not show evidence of degeneration with conventional MR. The effect may be due to organic iron entering the disc and decreasing its T1 and T2. In vivo MR measurements, with RF implantable coils, of myelin water content in rat spinal cord (SC) are presented. Data from a multi-echo CPMG sequence were used to calculate T2 distributions within SC. The myelin water fraction of GM and WM in control rat SC was measured as 13.2% and 25.1%. In a contusion-injured rat SC, qualitative observation suggests that the T2 distribution immediately after injury differs significantly from the control cord, but reverts to a T2 distribution closer to normal by the 4th day after contusion. This technique can provide useful information about myelin structure in SC injury.
Magnetization transfer (MT) has the potential to provide information on tissue composition. The present study aims to characterize axonal degeneration and regeneration in live excised lamprey spinal cord by means of NMR microscopy, using magnetization transfer contrast. Magnetization Transfer Ratios, calculated on different regions of the white matter above and below the transection site, decrease as axons degenerate and recover toward normal values while axons regenerate and animal functionally recovers. This supports our hypothesis that MTR variations correlate with axon membrane density and may be used to detect axonal changes in response to trauma and repair.

Larval sea lampreys (Petromyzon marinus) have been used for some time as a model for axonal degeneration and regeneration. Here we report MR microscopy techniques at 9.4 T developed for imaging the spinal cord in a live lamprey. A custom-designed RF surface coil is described and MR micro-images are shown of an anesthetized lamprey at high-resolution (voxel size = 9.7x9.7x250 µm³) The images were acquired in reasonable scan times and demonstrated high SNR and excellent detail for anatomical structures. Such techniques will facilitate longitudinal studies of spinal cord injury and regeneration in this animal model.

Experimental allergic encephalomyelitis (EAE) is an immune-mediated inflammatory demyelinating animal model affecting the CNS. In this study nine EAE diseased pig spinal cords and three controls were studied by T1-, T2- weighted MRI and high b-value q-space Diffusion MRI (q-space DWI). In all nine EAE diseased spinal cords the q-space DWI maps were different from that of the control maps. Diffusion MRI showed that abnormalities in the EAE diseased spinal cords exceed the areas of the plaques. This study provides the first characterization of the EAE model in pig spinal cords using conventional and high b-value q-space diffusion MRI.

Excessive scar formation following laminectomy can lead to epidural tethering and can cause pain – the “failed back syndrome”. To better understand the pathophysiology and evaluate potential mechanical or pharmacological interventions, there is a need for a reproducible animal model. We present the utility of the New Zealand White rabbit as a surgical model combined with MRI for producing a reproducible surgical lesion and MRI demonstration of postoperative scar formation. Measurements of the area of epidural scar was readily quantifiable. This can be integrated with histological and biomechanical measures. It also provides a platform for evaluating potential therapeutic interventions.

The objective of this study was to assess the value of ultrashort TE (UTE) pulse sequences for imaging the lumbar spine. Pulse sequences of TE=0.08 msecs were used in five normal subjects and 12 patients with degenerative disease. High signal was seen in the anterior and posterior longitudinal ligaments, the regions of the cartilaginous end plate, the annulus fibrosus, the ligamentum flavum, interspinous ligaments and insertions of ligaments. Enhancement of hypertrophied ligaments and scar tissue was readily identified. Enhancement in discs was more obvious than with conventional sequences. UTE sequences offer new options for imaging structures of the lumbar spine.
13:45  1543.  Enhanced MRI Findings in Two Groups of LBP Patients and Asymptomatic Controls – Baseline Data
Tue Secher Jensen¹, Joan Solgaard Sorensen¹, Hanne Albert¹, Claus Manniche¹
¹University of Southern Denmark, Ringe, Denmark

The aim of this study was to identify inflammation in tissue that might have effect on sciatica and LBP. Three groups of patients, 68 patients with LBP and subacute sciatica, 57 patients with LBP only, and 32 asymptomatic controls were scanned using a standard MRI-protocol on an 0.2 T MRI-system (Siemens Open Viva). All patients were administered Gadolinium according to bodyweight. Results from this study show that there were significant differences between groups with respect to enhancement in protrusions, nerve roots, facet joints and endplates. There were no significant differences between groups with respect to enhancement in discs and HIZ.

13:46  1544.  High resolution T₁ρ Relaxation and Dispersion Imaging of Intervertebral Disc
Ravinder R. Regatte¹, Sarma VS Akella¹, Ari Borthakur¹, Ravinder Reddy¹
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

We measured the spatial variation of spin-lattice relaxation time in the rotating frame (T₁ρ) and dispersion of bovine intervertebral disc specimens. Significant variation of T₁ρ as a function of spin-lock frequency, termed ‘T₁ρ dispersion’, was observed between 0 and 3kHz. The T2 relaxation times computed in the regions of interest range from 35-45ms whereas the T1ρ-relaxation times (with a 500Hz) range from 125-145ms. The higher dynamic range in T1ρ not only provides higher signal to noise ratio and improved contrast between annulus fibrosus and nucleus pulposus but also improves the precision of the measurement of relaxation times.

13:47  1545.  3T Hi-Resolution Cervical Spine 3T
Paul Y-K Wang¹, Brian Mumford¹, Iwan Tjauw¹, Greg Wilson²
¹OHSU, Portland, Oregon, USA; ²Philips Medical Systems, Seattle, Washington, USA

T2*FFE (spoiled gradient echo) was compared to balanced SSFP (B-FFE) for cervical spine 3T MRI in 25 patients. Assessment of the anatomy affected in spinal degenerative joint disease for image quality and diagnostic relevance was made. Both sequences were found to be useful in cervical spondylosis, B-FFE was found to be more tolerant of patient motion and depicted canal narrowing better than FFE but showed less contrast in depiction of foraminal fat and less able to indicate the disc space.

Deborah Jane Annesley-Williams¹, Andrew Cooper¹, Tim Jaspan¹, Robert Lenthall¹
¹Queens Medical Centre, Nottingham, UK

This study demonstrates the role of contrast enhanced magnetic resonance angiography (CEMRA) in the detection of spinal vascular malformations. 7 patients were examined with CEMRA and spinal angiography. MRA was performed following injection of paramagnetic contrast using a 3DT1FFE technique with sagittal orientation. 3 dural arteriovenous fistulae (DAVF) and 2 pial arteriovenous malformations were identified with 3D CEMRA and confirmed with spinal angiography. In 2 patients with DAVF abnormal vessels were seen but the level of the fistula could not be demonstrated. 3D CEMRA is a useful diagnostic tool in the evaluation of spinal vascular malformations and complements spinal angiography.

RF Coil Theory, Design, and Construction

Room C-2  Monday 14:00 - 16:00

14:00  1547.  Design of High Frequency Volume Coil Using MTL Resonators: A Simple Solution to the RF Volume Coil Design at Ultra-High Magnetic Fields
Xiaoliang Zhang¹, Wei Chen¹
¹University of Minnesota, Minneapolis, Minnesota, USA

In this work, we developed a simple volume coil using the microstrip transmission line (MTL) method operating at 400 MHz. The coils can be readily tuned up to 1.2-1.4 GHz. Resonant frequencies for a single MTL resonator with terminative capacitors and assembled MTL volume coil were derived. The results of this study provided a simple and efficient solution to designing ultra-high frequency volume coil. This MTL volume coil operating at 1.2 GHz could also be used as a coil for electron excitation in animal Overhauser MRI (OMRI) applications in vivo at an EPR B0 of ~43 mT.

14:01  1548.  An Elevated Endring Birdcage Coil for Improved Performance at 3 Tesla
Daniel Weyers¹, David Keren¹, Eddy Boskamp¹, Graeme McKinnon¹, Kevin Kinsey²
¹GE Medical Systems, Waukesha, Wisconsin, USA

Signal-to-noise (SNR) limitations have driven development of clinical high field systems (3.0T or greater). At such frequencies (128MHz and greater), the interaction between the B1 field and the patient cannot be neglected. Such a strong interaction degrades homogeneity of the B1 field, negatively affecting image quality and causing an increased tendency for image shading. Limits on specific absorption rate (SAR), including new standards allowing 4 W/kg, have escalated concerns of patient safety, thus requiring efficient body coil designs utilizing E field reduction techniques.
14:02  **1549. The Quartz TEM Coil: Improved Performance at 3.0 Tesla**

Michael B. Smith¹, J. Thomas Vaughan²

¹Penn State College of Medicine, Hershey, Pennsylvania, USA; ²University of Minnesota, Minneapolis, Minnesota, USA

The objective of this study was to produce the greatest sensitivity possible in a TEM resonator at lower frequencies where the TEM is not frequently utilized (e.g., 3T). Sensitivity is increased with elimination of the lumped element capacitors usually required to achieve resonance in such a structure at lower frequencies, relying entirely on the distributed capacitance within the transmission line elements. This requires a significant increase in the dielectric constant of the insulator in the elements, accomplished here by replacing Teflon with quartz.

14:03  **1550. Optimization of Carotid Coils**

Susan Mathew¹, Eddy Boskamp², Bernice Hoppel¹, Elaine Hillary Locke¹, Leroy Blawat², Bruce A. Wasserman³, Steve M. Wright¹

¹Texas A&M University, College Station, Texas, USA; ²GE Medical Systems, Milwaukee, Wisconsin, USA; ³John Hopkins University, Baltimore, Maryland, USA

High resolution MR imaging has a great importance on the diagnosis of vulnerable carotid plaque, which is one of the leading causes of stroke and also other manifestations of the disease, i.e. vascular death, myocardial infarction etc. This paper describes the optimization of carotid coils, considering SNR, depth penetration, resolution, field homogeneity etc. Two-, four-, six- and eight channel coils with different dimensions and geometries were made and compared. Finally a 6-channel coil was compared using a standard 3-inch loop using IR FSE technique.

14:04  **1551. Wire-Wound B₁ Coils for Low Frequency MRI**

C. P. Bidinosti¹, I. S. Kravchuk¹, J Cha¹, N A. David¹, M E. Hayden¹

¹Simon Fraser University, Burnaby, British Columbia, Canada

We describe the design, construction, and implementation of new simple wire-wound coils for producing homogeneous B₁ fields that are suitable for low field MR applications such as hyperpolarized noble gas lung imaging.

14:05  **1552. Space Optimized Birdcage Body Coil for Animal MR at 500 MHz**

Hellmut Merkle¹, Afonso C. Silva¹, Jung Hee Lee¹, Shella Keilholz¹, Alan P. Koretsky¹

¹National Institutes of Health, Bethesda, Maryland, USA

A space-optimized transmit coil is presented, consisting of an 89 mm OD and 70 mm ID shielded birdcage coil for in-vivo studies of small animals at 500 MHz. The high-pass design can be easily constructed, has good homogeneity, and can be operated either in transceive mode, or as a transmit-only coil in conjunction with actively decoupled probes or arrays.

14:06  **1553. Shielded And Unshielded High-Pass And Hybrid Birdcage Resonators For Use At 3T And Above: A Comparison**

Satheesh Vamanan¹, Sudath Dayasundara¹, Joseph S. Gati¹, Ravi S. Menon¹, Enzo Barberi¹

¹Robarts Research Institute, London, Ontario, Canada

A comparative performance study of high pass and hybrid birdcage RF resonators, with and without shielding at 4T is presented. The results show the performance advantage of the hybrid birdcage resonator relative to the conventional high-pass birdcage resonator. Moreover, with sufficient discretization of the birdcage structure and uniform distribution of discrete lumped-element capacitors, the unshielded hybrid birdcage resonator provides an excellent RF homogeneity and sensitivity. This results suggests that a high performance unshielded open hybrid birdcage resonator is an appropriate choice for high field clinical and research applications where a closed, shielded design is not practical.

14:07  **1554. Transmit/Receive High Resolution Knee Array**

Charles A. Saylor¹, Uli Gotshal¹, Asdrubal Mata¹, G. Randy Duensing¹, Craig Culver¹, Robert Dobberstein¹, David Molyneaux¹

¹MRI Devices Corp, Gainesville, Florida, USA; ²MRI Devices Corp, Waukesha, Wisconsin, USA

The next generation of extremity MRI coils will require a phased array design to support parallel imaging, decreased scan times and increased SNR. The additional desire to reduce the SAR and the phase wrap artifacts may require that the next generation of extremity coil be designed as a T/R phased array. This paper introduces a T/R phased array designed for imaging the knee. The coil is ergonomically designed permitting the elements in the receive array to be located in close proximity to the knee, for increased SNR, while still being large enough to fit more than 95% of the patients.

14:08  **1555. Birdcage Array for Lower Extremity Imaging**

Ryan Brown¹, Eric Reid¹, Azma Mareyam¹, Yi Wang¹

¹University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

We investigate the use of shielded birdcages dedicated to imaging the calves. The array consists of two birdcage coils placed on cylindrical formers that fit around the legs. The coil array has the ability to image both legs simultaneously over a 65 cm longitudinal field of view (FOV). Experiments using phantoms show an increase in SNR through the center of the coil over the standard GE head coil and 12 channel peripheral vascular (PV) coil. Preliminary data show that the birdcage array provided more vascular details in angiographic images than the head coil.
Open Volume TEM Quadrature Coil for High Field Imaging
Alexey Peshkovsky1, Richard P. Kennan1, Mary E. Fabry1, Nikolai I. Avdievich1
1Albert Einstein College of Medicine, Bronx, New York, USA

A half-open seven-element volume quadrature TEM coil has been developed by utilizing two orthogonal resonant modes made degenerate in frequency and operated 90 degrees out of phase. The coil combines the features of a volume and surface devices, providing large B1 homogeneous region as well as improved efficiency, patient comfort, and accessibility. Additionally, it self-compensates the RF penetration artifact, which is generally observed for linear coils at high frequencies. The design details as well as the results of the phantom and volunteer studies are provided.

High Resolution Imaging at 4.7 T using Four Irregularly-Shaped Receiver Coils
Roger John Ordidge1, David Carmichael1, Navjeet Chhina2, Mark Cooper2, Enrico De Vita1, Chris Randell2
1University College London, London, UK; 2Pulseteq Ltd, Guildford, Surrey, UK

The efficiency of surface coils depends on their close proximity to the tissue being imaged. Regularly shaped coil arrays only achieve close coupling for regularly shaped regions of the body e.g. the dome of the head. We have developed an array of four coils which fit together to follow the contours of the human head and provide a SNR improvement for almost all brain regions compared to a standard birdcage head coil. Furthermore, the coils have been designed to be compatible with audio-visual communication with the patient and can be used to speed up data collection using parallel imaging.

4T Human Brain Spectroscopic Imaging with Four-Channel Phased Array
Nikolai I. Avdievich1, Hoby P. Hetherington1
1Albert Einstein College of Medicine, Bronx, New York, USA

The design and construction of an actively detuned TEM volume transmit/four-channel phased array receive RF system, developed for 4T (170 MHz) magnetic resonance spectroscopic imaging (MRSI) of a human brain, is described. Decoupling between the surface coils in the array is achieved by overlapping the coils, and by utilizing low impedance preamplifiers in combination with quarter wavelength transmission line transformer matching. Peripheral SNR improvement by a factor of 4 - 6 was achieved, as compared to a TEM volume head coil. Results for spectroscopic imaging of a human brain with spatial resolution of 0.125 ml are presented.

A Comparison of Double Tuned Birdcage and Spiral Birdcage RF Coils.
Scott B. King1, Vyacheslav Volotovskyy1, George R. Duensing2, Boguslaw Tomanek1
1Institute for Biodiagnostics, Winnipeg, Manitoba, Canada; 2MRI Devices Corporation, Gainsville, Florida, USA

Performance of multiple frequency volume RF coils designed for 4.7T/30cm horizontal bore magnet has been investigated. Three coil types (spiral birdcage, four-ring birdcage and alternate tuned elements birdcage) have been compared with single frequency birdcage coil. Our results show that the alternate tuned elements birdcage method retains most of the SNR of single tuned birdcage coils while preserving z-axis homogeneity, while the +p and -p spiral birdcage and four ring birdcage methods sacrifice SNR and z-axis homogeneity respectively at a lower frequency.

Endcap Design for Phased-Array Coils
Jovan Jevtic1, Velibor Pikelja1, Matt Mercier1, Ashok Menon1
1IGC-Medical Advances, Inc., Milwaukee, Wisconsin, USA

Conventional endcap for RF head coil provides very poor RF mirroring performance when used in a phased-array coil because the radial cuts strongly interfere with the natural flow pattern of the induced RF currents. We will present an endcap design which is compatible with the phased-array coils. After the flow pattern is determined using a computational electromagnetics tool, the endcap is cut out of a double sided printed circuit board along the calculated natural streamlines while maintaining the prescribed maximum solid copper-patch diameter. The measured RF mirroring performance is undistinguishable from the equal sized solid copper endcap.

Cryogenic Litz-Wire Receiver for Low Field MRI
Frank Resmer1, Hugh Seton1, James M. S. Hutchison1
1Aberdeen University, Aberdeen, Grampian, UK

We describe a cryogenic surface RF coil for use with a 0.01 vertical field MRI system. The coil is made from litz wire and makes use of a planar gradiometer winding which, as well as providing the correct B1 field orientation, also provides a degree of immunity to external RF interference. The coil is housed in a fibreglass cryostat, so that it can be cooled to 77K with liquid nitrogen. The coil has been tested with small test objects, but we hope to use it to improve the SNR of low field MRI studies of limb joints.
A New Microstrip Resonator Coil for Imaging Rhesus Monkeys

Gene Bogdanov1, Mathew Breward2, Timothy Fisher1, Craig Ferris1, Reinhold Ludwig2
1Worcester Polytechnic Institute, Worcester, Massachusetts, USA; 2University of Massachusetts Medical School, Worcester, Massachusetts, USA

The microstrip volume coil design has been successful in small animal (rat and marmoset) imaging applications at 4.7T, and has recently been scaled to operate at 11.7T. In this paper we discuss the scaling of this coil concept to larger sizes, suitable for rhesus monkey head imaging at 4.7T. It is demonstrated that such coils of larger dimensions are feasible and provide satisfactory performance. In addition, the previously developed optimization strategy is employed and the resulting field homogeneity allows imaging very close to the coil strips.

HTS Tape Volume Coil for Human Wrist Imaging

M. C. Cheng1, K. H. Lee1, D. F. Kacher2, Q. Y. Ma1, F. A. Jolesz3, E. S. Yang2
1University of Hong Kong, Hong Kong, Hong Kong; 2Harvard Medical School, Boston, Massachusetts, USA

High Temperature Superconductor (HTS) tape RF receiver coil has been developed to improve MR image quality. Compared with HTS thin-film, one unique advantage is its potential to be developed as volume coil. In this paper, we present a HTS tape solenoid coil for human wrist imaging at 0.2T MRI system. SNR improvement of 230% was observed over an equivalent room-temperature copper solenoid. Although its SNR is similar to the standard GE solenoid wrist coil, the latter has three times better filling factor. Therefore, it is expected to outperform the GE coil in SNR upon optimizing the filling factor.

A Distributed Capacitor Endcap for Head Coils at 1.5T and 3.0T

Cecil E. Hayes2, C. Mark Mathis1
1University of Washington, Seattle, Washington, USA

We have built bandpass birdcage head coils at 1.5T and 3.0T equipped with a distributed capacitor endcap. The endcap consists of a mesh of many equal sized capacitors etched on Teflon circuit board. It serves as an RF mirror to improve B1 homogeneity but also supports tangential electric fields in order to distribute the electric fields uniformly around the head. Its multiple small segments minimize the eddy currents induced in the shield by gradient field switching. The endcap coils provide a 31% increase in SNR compared to the standard GE Sigma head coil at both field strengths.

Multiline Transmission Line Modelling and Experimental Testing of 3 T TEM Resonators

Assunta Vitacolonna1, Giuseppe Placidi2, A Sotgiu1, Peter Jezzard3, Marcello Alecci1
1INFM and University of L’Aquila, L’Aquila, Italy; 2INFM and Centro RM, L’Aquila, Italy; 3University of Oxford, Oxford, UK

In this work we have modified the MTL model, for simulation of the TEM resonators response, by including the following features: 1) accounting for the short coaxial element approximation; 2) including within the model losses in the coaxial elements; 3) allowing for asymmetrical (front-back) adjustment of the tuning rods. We present theoretical data and a comparison with experimental results obtained with a 3 T head-sized TEM prototype composing 24 elements.

Optimal Multiple-Element Driving Configuration Depends on Head Geometry, Placement, and Volume of Interest

Christopher Michael Collins1, Bryan J. Swift1, Wanzhan Liu1, J. Thomas Vaughan2, Kamil Ugurbil2, Michael B. Smith1
1Penn State College of Medicine, Hershey, Pennsylvania, USA; 2University of Minnesota, Minneapolis, Minnesota, USA

One method that can be used to improve image homogeneity at high field is to vary the phase and/or magnitude of the separate elements in a transmit/receive coil or coil array during transmission. Here we examine how the phases and magnitudes required for generation of optimally uniform images vary as a function of head geometry, placement of the head in the coil, selection of a volume of interest, and definition of the criteria for a “homogeneous” image.

Evaluation of SAR and B1 for a Transceive Pelvic Phased-Array Coil at 3T using FDTD Simulations

Hee-Won Kim1, Jim Caserta2, David M. Peterson1, Jeffrey R. Fitzsimmons1
1University of Florida, Gainesville, Florida, USA; 2Analog Devices, Winston Salem, North Carolina, USA

The finite difference time domain method is used to predict local SAR and B1 field depending on the phase in a transceive pelvic phased-array (TPPA) coil for 3T whole body magnet. The four-element TPPA is modeled and tuned to 128MHz. Several quadrature drives are compared to a linear drive. The FDTD methods properly simulated SAR and B1 distribution over the FOV and showed maximum absorption in the skin and muscle, due to the strength of the field in the skin and the conductivity of the muscle.

A Design Tool for Optimized RF Coil Array Design

J. Rock Hadley1, Dennis L. Parker1
1University of Utah, Salt Lake City, Utah, USA

This work describes an RF coil design tool for developing linear coil arrays targeted at elongated structures of varying depths, such as the carotid arteries. The technique uses analytic expressions of coil sensitivities as functions of coil size relative to structure depth in a 2D model to evaluate the SNR along centerpoints of model vessels. By determining the optimal number of coils, and the radius and position of each coil, these results help to predict the optimal number of coils to be used for imaging along the entire length of the carotid arteries.
Due to the wave behavior of the B1 field inside a body sized object at B0 fields \(\geq 3\)T the clockwise rotating transversal B1 field component may be actively controlled by adjusting the transmitting amplitudes and phases of a T/R coil array. In applications in phantoms and in vivo employing a 4-channel T/R array we demonstrate the feasibility of this B1 steering capability for a 3T MR scanner equipped with four fully independent transmit channels. In this way adaptive coil control schemes like B1-shimming, "switched" B1-gradients, transmit SENSE and RF-controlled volume selection may be utilized in high and ultra-high field MR.

The multiconductor transmission line formalism is applied to the birdcage coil to account for the distributed electromagnetic coupling along its legs. It provides a means to calculate the resonant spectrum with greater accuracy than using traditional lumped-element circuits, especially at high operating frequencies, while being computationally advantageous over numerical methods.

In this work, an analytical evaluation of the MR signal is presented using the principle of reciprocity for any transmit and receive coil(s) with general geometrical structure(s). The excitation of the spins in the transverse plane can not be explained using the principle of reciprocity in its standard form due to the asymmetry in the permeability tensor. The received NMR signal was calculated from the produced magnetization using the standard form of the principle of reciprocity.

The improved SNR of an image obtained with MRI phased arrays becomes possible due to parallel post-processing of the signals received by separate loops. Further SNR improvements may be achieved with an increased number of loops. However, the number of available parallel channels remains constant. One way to overcome this limitation is to hardware combine at least some of the loops. We use a lumped element Rat Race coupler to combine the two channels of a two element array, so that the correlated noise is cancelled out at the output. Theoretical results are confirmed by the experimental data.

Arterial Spin-Labeling has proven to be a powerful technique for mapping brain activity, but has thus far been limited in its ability to map function throughout the whole brain due to the poor homogeneity and depth penetration of the surface coils used for image acquisition. We have improved upon existing ASL techniques by integrating an arterial spin-labeling coil into a dual coil imaging system and restrainer especially designed for imaging conscious animals. Significant gains in SNR and homogeneity have been achieved, with a marked improvement in basal brain response detection.

The dynamic disabling switch for 7T self-shielded birdcage coil was designed based on the distribution circuit. Two designs were evaluated. The one with better performance was implemented into a 32 rung self-shielded high-pass birdcage coil. Q value of the birdcage coil was down by 20% after the implementation. Q value of 12cm x 12cm surface coil was down by 48% in the disabled self-shielded birdcage coil. These degradations were still thought acceptable, considering the ratios of Q without load to Q with load were 5 for birdcage coil and 23.9 for surface coil respectively.
14:28 A Novel RF Coil: Tunable Loop Microstrip (TLM) Coil

Bing Wu¹, Peng Qu¹, Jing Yuan¹, Gary X. Shen¹
¹The University of Hong Kong, Hong Kong, People's Republic of China

A new tunable loop microstrip (TLM) RF coil for MRI is presented. It is a novel approach to use tuning capacitor on microstrip ring resonator. The resonant frequency and Q are analyzed based on microstrip theory. The experiment results show its advantages of higher Q and less frequency shift with loading effect than conventional microstrip coils terminated with open or short circuit. Because of its tunable characteristics, this new TLM coil can be easily applied to high and particularly to ultra-high filed MRI systems.

14:29 A New Array Design using Tunable Loop Microstrip (TLM) Coil

Bing Wu¹, Peng Qu¹, Chunsheng Wang¹, Gary X. Shen¹
¹The University of Hong Kong, Hong Kong, People's Republic of China

A new array, tunable loop microstrip (TLM) array for MRI has been developed. The theoretical analysis of decoupling of a 2-element TLM array is based on microstrip theory. The experiments of comparison between the TLM array and a conventional loop array show that TLM array has great decoupling performance. This effectiveness is further demonstrated by 1.5T cardiac images. Thus, without overlap of array elements TLM array will be particularly useful for parallel imaging applications.

14:30 Computed SNR of a Phased-Array of Two PERES Coils Outperforms that of Two Circular Coils

Alfredo Odon Rodriguez²
²UAM Iztapalapa, Mexico, DF, Mexico

A computational comparison of SNR was performed between the phased-array of two circular-shaped coil and Petal Resonator Surface coils. The quasi-static model was used to derive SNR formula for each type of coil. These formula were combined with the phased-array optimum SNR to obtain a SNR formula for each case. Mutual interaction was excluded from the model. Theoretical-acquired SNR-vs-distance profiles were plotted for both arrays at various coil centre separations. A comparison plot was computed to investigate coil performance. Phased arrays of PERES coils show up to a 110% improvement over the circular coil.

14:31 A Four Channel Transmit Receive Microstrip Array for 17.6T

Tobias Wichmann¹, Daniel Gareis¹, Mark Griswold³, Thomas Neuberger¹, Steven Wright², Cornelius Faber¹, Andrew Webb¹, Peter Jakob³
¹University of Würzburg, Würzburg, Germany; ²Texas A&M University, College Station, Texas, USA

A four channel transmit/receive microstrip array was designed and constructed for 17.6 T imaging system. Each of the coils was 30mm x 44mm in size and were oriented in 0,90,180,270 degree positions around an inner diameter of 43 mm. The microstrips used a 0.7mm thick G10 substrate as dielectric between the strip conductor and the ground plane. With the coils in this orientation, the transmitter voltage of each coil could be phased in order to achieve a homogeneous transmit pulse. Both workbench and imaging experiments performed at 17.6 T showed good isolation even though no additional decoupling circuitry was needed.

14:32 Optimization of HTS Tape Coil Design

Jing Yuan¹, Chunsheng Wang¹, Gary X. Shen¹
¹The University of Hong Kong, Hong Kong, People's Republic of China

HTS tapes are promising materials for RF coil due to their advantages of easier fabrication, easier frequency adjustment and lower cost over HTS films. A theoretical model was developed to investigate the relationship of Q with coil size, solder joint and resonant frequency. The model showed that Q increased with size and frequency. The model would be helpful in coil design to increase Q and hence increase SNR. Bi (2223) tape coils with different sizes and resonant frequencies were fabricated to verify the theoretical model.

14:33 MATCOIL: A Matlab Based Program for the Calculation of B₁ Fields and Sensitivity Profiles for Surface Coils (Single, Multiple, or Quadrature Driven) of Arbitrary Shape and Curvature

Thomas Schleich¹, Gerald B. Matson²
¹University of California, Santa Cruz, Santa Cruz, California, USA; ²VA Medical Center, San Francisco, California, USA

A user friendly program, designated MATCOIL (quasi-static approximation), for the calculation and display of B₁ field and reception sensitivity profiles for surface coils of arbitrary shape and curvature, including multiple coils, and coils driven in quadrature has been developed in MATLAB. Through a series of figure menus, the coil configuration is readily defined, and outputs (in different formats) calculated for the B₁ field, relative tip angle, and reception sensitivity for a given TR/T₁ ratio. We envisage this program to be useful for the design and evaluation of different surface coil probe designs.
In the past, open MR systems had an inferior image quality, mainly because of their low field. Recently, mid-field open MR systems have been introduced and MR manufacturers are developing 1T open systems. The signal-to-noise ratio (SNR) of receive-coils for an open MR system (vertical field) has been compared to that of cylindrical systems (horizontal field). Most coil elements of vertical field systems enclose the object, resulting in a higher filling factor. This is preferred for SNR. Measurements and simulations show that 1.0T open systems have a comparable SNR as 1.5T cylindrical systems for the coil layout as described.

Metamaterials manipulate RF fields and fluxes in a variety of ways, but to use them successfully in MR applications, additional components such as flux compressors are required. We have modelled and measured two forms of compressor: a tightly wound solenoid, and one based on multiple resonant coils. The devices were characterized using two loops, one matching the input and one the output diameter. There is remarkably good agreement between the measured data and the theoretical predictions. Using these devices in a yoke, it should be possible to minimize gradient coil apertures, while achieving excellent RF performance.

With the recent growth in the number of receiver channels available on clinical MRI systems (now at up to 32), it is important to consider the losses incurred when many small coils are used to cover a large area. In this work losses due to coil conductor resistance is considered for certain types of arrays. The study demonstrated that for arrays of many overlapped elements, the loss of each small loop should be sample load dominated and that for typical design of 16 channels, a loss of up to 20% might occur.

A surface coil structure to overcome mutual inductance of parallel surface coils is presented. The concept is based on the addition of a shielding coil mounted on each tuned RF receiver coil. On one side of the shielded coil structure, the effective coupling factor to a nearby coil is greatly reduced. By this means, a pair of coils can be decoupled over varying geometries without any tuning or matching adjustment. This decoupling approach allows improved SNR over highly coupled coil arrays without external circuitry or calibration in situations where the geometry of coil array placement may be variable.

Transmit coils for MRI are designed as parallel resonant circuits, excited by a voltage source. Thus, coil current distribution is determined by the local coil impedances. At frequencies of 128MHz and above, asymmetrical loading of coil with lossy sample causes B1 field inhomogeneity. B1 field homogeneity could be optimized by adjusting the amplitudes and phases of the currents on each rung independently. We present a RF current source design that would drive RF current through each rung. We show that the amplitude and phase of the output current are controllable.

A novel coil architecture for spine and body imaging is presented. These so-called “Matrix Coils” allow the use of a scalable number of receivers as a function of desired acceleration factor for parallel imaging and for desired SNR in peripheral regions. SNR comparisons between these novel coils and existing CP array coils were performed. It is shown that for non-parallel imaging the SNR along the main patient axis is comparable. In addition however, the novel Matrix Coils allow parallel imaging in left-right direction by using extra channels which are not available in standard CP array coil design.
Arne Reykowski1, Mathias Blasche1
1Siemens Medical Solutions, Erlangen, Germany

A novel approach to array imaging involving pre-combined signals is presented. The method is mainly geared towards parallel imaging techniques which require array elements stacked in phase encoding direction. It is shown that pre-combining signals using a so called “Mode Matrix” allows scaling of the number of necessary RF channels as a function of the acceleration factor.

13:32 1588. Design Optimization for Phased Array Coil Decoupling and Tuning
Brian S. Brown1, Jovan Jevtic1
1IGC-Medical Advances, Milwaukee, Wisconsin, USA

A new predictive engineering design process that optimizes the loop-to-loop decoupling and tuning for arbitrarily shaped phased array coils is presented. The method links partial inductances obtained from an electromagnetic simulation with discrete component impedances to characterize impedances throughout the coil. Optimization methods are used to obtain decoupling and tuning component values. Results are presented for decoupled four and eight channel phased arrays and are in excellent agreement with measured data.

13:33 1589. How to Optimise a 16 Channel Neurovascular Coil for SNR, Sense, Patient Comfort and Inter-Element Coupling.
Marcel Warntjes1, Emiel Kuipers1, Bob Selder1
1Philips Medical Systems, Best, Netherlands

A RF receive coil for neurovascular MR imaging is optimised, without the restriction of a limited number of channels, for the best SNR and Sense performance needed for all neurovascular applications. On top of this, the coil is modified for a better patient comfort and minimal inter-element coupling. The optimisation is a careful balance of numerous parameters, checked both in simulations and with a feasibility model. The road towards the design and the resulting MR images are presented.

13:34 1590. SENSE Imaging with Quadrature Half-Volume TEM Coil at 4T
Nikolai I. Avdievich1, Alexey Peshkovsky1, Richard P. Kennan1, Hoby P. Hetherington1
1Albert Einstein College of Medicine, Bronx, New York, USA

SENSE parallel body imaging is difficult to realize at high field strength due to a lack of efficient body volume coils providing homogeneous transmission. Alternatively, a transmit/receive quadrature half-volume coil can be employed for SENSE body imaging with multi-channel reception using frequency-degenerate isolated modes of the same half-volume coil. This type of coil provides efficient transmission with sufficiently large region of homogeneity and improved reception profile as compared to receive surface coils. As proof of concept, this work presents results using an original open transmit/receive half-volume quadrature TEM coil for SENSE human brain imaging at 4T.

13:35 1591. A 6-Element Array for Parallel Wrist Imaging at 3 Tesla
Nicola De Zanche1, Christoph Leussler2, Hendrik Mandellkow1, Klaus Pruessmann1
1University and ETH, Zurich, Switzerland; 2Philips Research Laboratories, Hamburg, Germany

A 6-element array of miniature coils for wrist imaging is presented and its performance is characterized. While SNR is highly favorable and allows very high resolution imaging, improvements are nevertheless possible in cryogenic conditions. The SNR advantage can also be traded for scan speed, leading to clinically acceptable scan times.

13:36 1592. Considerations for Enhanced SNR Performance of a Spiral Array Coil with Many Elements using a Common End Ring Design
Matthias Mueller3, Titus Lanz3, Martin Blaimer1, Felix Breuer1, Robin Heidemann1, Andrew Webb1, Mark Griswold1, Peter Jakob1
1University of Wuerzburg, Wuerzburg, Germany; 3RAPID Biomedical, Wuerzburg, Germany

Several recent studies have shown that a double spiral array coil configuration appeared to be a promising array set-up due to construction difficulties and imaging performance for high-performance massive parallel 3D imaging. The goal of this work is to determine how many array channels are feasible for a routine head coil array. In addition loss mechanisms of a spiral coil are discussed and a common end ring double spiral array design is introduced increasing the intrinsic signal to noise ratio of a spiral array coil.

13:37 1593. Eight-Channel Transmit/Receive Triangle Coil for 3D SENSE
Derek Seeber1, William Johnson1, H. Douglas Morris2
1IGC Medical Advances Inc., Milwaukee, Wisconsin, USA; 2National Institutes of Health, Bethesda, Maryland, USA

A triangular element coil has been demonstrated to permit SENSE in all three orthogonal directions. Eight right triangles, with alternating diagonals, wrapped around a cylinder, has been used in a receive-only configuration. However, for z-directional (superior/inferior) SENSE, the phase encode direction is along the superior/inferior axis, increasing the foldover artifact, wrapping of the chest and neck back into the head. The foldover artifact is caused by the excitation of these spins by the body coil outside the field of view of the image. This foldover artifact can be minimized by configuring the triangular element coil as a transmit/receive coil.
**Poster Sessions**

**13:38  1594. Triangular Element Vertical Field Torso Coil for 3D SENSE**
*Derek Seeber*, *Nunez Tatum*, *Jovan Jevtic*, *Mark Winebrand*

IGC Medical Advances, Milwaukee, Wisconsin, USA

Vertical field MRI systems require vastly different coil geometries than horizontal field systems and this difference becomes especially true when designing SENSE optimized MRI coils. Usually, vertical field coils consist of solenoid elements, which provide good homogeneity and coverage. However, solenoid coil elements provide limited SENSE accelerations abilities as sensitivity from individual elements have slow sensitivity drop-offs. A torso coil was developed for vertical field MRI systems consisting of eight triangular elements that where combined in quadrature to be compatible with current four channel systems, and optimized for SENSE capability in all three orthogonal spatial directions.

**13:39  1595. A Novel “Smart” Neurovascular Array Coil System for Parallel Imaging**
*Kazuya Okamoto*, *Mitsuo Takagi*, *Manabu Ishii*, *Yasutake Yasuhara*, *Hiroyuki Fujita*, *Yuqian Zhang*, *Clarence Payton*, *Michael Donofrio*

1toshiba Medical Systems Corporation, Otawara, Tochigi, Japan; 2Toshiba Medical System Engineering Co.,Ltd., Otawara, Tochigi, Japan; 3USA Instruments, Inc., Aurora, Ohio, USA

A conventional neurovascular coil is often made available as an optional coil, so the operators end up with purchasing both a head coil and a neurovascular coil because of different requirements for ROI. As a result, this practice takes excessive cost and leads to lower throughput to have both coils. A noble neurovascular array coil system is proposed, which is a hybrid design of a multi-element head array coil and an additional array coil to cover from neck to upper thorax. The proposed design is capable of parallel imaging (PI).

**13:40  1596. 3T Breast Array Optimized for Parallel Imaging**
*LeRoy R. Blawat*, *Bernice E. Hoppel*, *Eddy B. Boskamp*, *Yugi Iwadate*

GE Medical Systems, Waukesha, Wisconsin, USA

A 3T Breast Array coil was designed and optimized for use with parallel imaging techniques. This design was also conceived to allow for an open structure that gives access to the breasts for biopsy procedures. Removable posterior elements also allow for a user-friendly coil design when biopsy procedures are considered. Incorporated into the design is the ability for the user to easily select combinations of coil elements that allow for bilateral or unilateral exams without switching cables.

**13:41  1597. A 10-Element Medial and Lateral Accessible Breast Coil Array Optimized for Parallel Imaging**
*Kun Qu*, *Pei H. Chan*, *Tsinghua Zheng*, *Cynthia Maier*, *Joe Murphy*

1USA Instruments, Aurora, Ohio, USA; 2GE Medical, Milwaukee, Wisconsin, USA

In this paper, we present a 10-element, 8-channel Rx breast coil optimized for both bilateral and unilateral SENSE imaging. The coil is also medial and lateral accessible for tissue biopsy. Furthermore, the coil provides good coverage of axillary tissue and higher signal-to-noise ratio (SNR) than 4-channel breast coils.

**13:42  1598. Multi-Direction SENSE Imaging using a Head Coil Based on Trianglular Elements with a Standard Clinical Scanner**
*H. Douglas Morris*, *Derek Seeber*

1National Institutes of Health, Bethesda, Maryland, USA; 2Medical Advances, Milwaukee, Wisconsin, USA

It is recognized that RF coil geometry plays a crucial role in SENSE performance. We test a new coil topology using triangular loops, specifically tailored for SENSE acceleration along all three orthogonal axes. the design allows for an additional 2-fold acceleration in the z-direction, without compromising the SENSE performance in the transverse plane, and without increasing the number of channels.

**13:43  1599. Investigating Tissue-Coil Interactions of an 8-Elements Transmit/Receive Torso Phased Array Coil**
*Bing Keong Li*, *Feng Liu*, *Ian Gregg*, *Nicholas Shuley*, *Stuart Crozier*, *Graham Galloway*

1University of Queensland, Brisbane, Queensland, Australia

Based on a full-wave solution of Maxwell’s equations, hybrid MoM/FDTD approach is used to help the design of some novel flexible array coils for the biological body. We theoretically investigated the RF field of an 8-element torso phased array coil loaded with an anatomically accurate model of the human torso. Several imaging related parameters such as B1 distribution, signal intensity (SI) and specific energy absorption rate (SAR) inside the torso are investigated. The simulated results are reported and demonstrate the feasibility of the design concept of phased array coils for torso imaging.

**13:44  1600. The SENSE Cardiac Coil for 4-channel Vertical Field MRI Systems**
*Limin Feng*, *Vincent Chen*, *Yun Jeong Yang*

1USA Instruments, Inc., Aurora, Ohio, USA

A new SENSE cardiac coil is designed for 4-channel vertical field systems. It consists of 4 element coils and has the optimized G factor in the anterior to posterior (AP) direction. The traditional body coil usually consists of the volume loop and saddle coils that provide the uniform sensitivity in a big area. It isn’t suitable for the cardiac SENSE scan because it has a very high G factor. The new SENSE cardiac coil combines the volume coil and surface coil structures in order to provide the high SNR and the low G factor for the SENSE scan.
Posters Sessions

13:45  **1601. Microstrip Loop Array (MLA) for Parallel Imaging**

*Peng Qu*, Bing *Wu*, Juan *Wei*, Gary X. *Shen*

1 The University of Hong Kong, Hong Kong, Hong Kong

The microstrip loop array (MLA), an improved version of planar strip array, is proposed which take advantage of loop geometry. Without much loss of the well-decoupling benefit of strip line arrays, the proposed microstrip loop arrays have well-localized sensitivity profiles which are more suitable for parallel imaging. Simulation and experiment results show that microstrip loop coils have sensitivity profiles like conventional loop coils, while the mutual coupling is 10-20dB less at same distances. A sensitivity-encoded cardiac imaging was performed to demonstrate the suitability of MLA for parallel imaging.

13:46  **1602. An MTL Coil Array with a Broad Frequency Tuning Range for Ultra-High Field Human MR Applications from 3T to 7T**

*Xiaoliang Zhang*, *Yu Liao*, Xiao-Hong *Zhu*, Wei *Chen*

1 University of Minnesota, Minneapolis, Minnesota, USA

Technical challenges in high-frequency coil designs have been an obstacle in MRI/MRS applications at high/ultra-high magnetic fields. A coil array was designed using two microstrip transmission line (MTL) resonator loops. The array is characterized with an extremely broad frequency tuning range from 115 to 310 MHz, quadrature B1 field and capability for parallel MRI. The broad tuning range makes the array suitable for proton applications at different fields from 3T to 7T, and/or for the study of both 1H and 31P nuclei at the same field strength of 7T. The flexibility in array configuration is suitable for different organ applications.

13:47  **1603. Comparison of RF Penetration and G-factor of Different Coil Arrays for Parallel Imaging**

Juan *Wei*, Peng *Qu*, Gary X. *Shen*

1 University of Hong Kong, Hong Kong, People's Republic of China

Geometry factor and RF penetration of different kinds of coil arrays for parallel imaging were evaluated by simulations using MATLAB and XFDTD software. The results show that the coil arrays with loop structure are superior to the planar strip arrays in terms of g-map and RF penetration. The overlapped loop array has better RF penetration, while the non-overlapped one has a lower noise level in parallel imaging.

13:48  **1604. An Elliptical Open-Faced Transceive Array for Ultra High Field Parallel Imaging and fMRI Applications**


1 University of Minnesota Medical School, Minneapolis, Minnesota, USA

We present an elliptical open-faced transceive array for ultra high field parallel imaging and fMRI applications. The array elements were decoupled by a decoupling capacitor network. Individual phase and amplitude control aided the compensation of field inhomogeneities caused by the missing elements in front of the face.

13:49  **1605. A Shielding-based Decoupling Technique for Coil Array Design**

*Peng Qu*, Bing *Wu*, Gary X. *Shen*

1 The University of Hong Kong, Hong Kong, Hong Kong

A new decoupling technique which takes advantage of shielding for coil array design is proposed. A ground plane is used to reduce mutual inductance by reducing the effective coupling loop area of circuits; in addition, a "screen track" is placed between adjacent coils to minimize magnetic interferences. This technique requires no modification of circuit and doesn’t cause loss of flexibility of coil geometry. Simulation and experiments show that a ground plane beneath surface coils can reduce mutual coupling by 10-20dB, and a "screen track" can further provide a 2-8dB more isolation.

13:50  **1606. The SENSE-Cage: A Half-Birdcage Volume Coil**

Timothy P. *Eagan*†, Jacob D. Willig-Onwuachi†, Shmaryu M. *Shvartsman*†, Y.-C. Norman *Cheng*†, Robert W. *Brown*†

1 Case Western Reserve University, Cleveland, Ohio, USA; 2University of California at Davis, Davis, California, USA; 3Philips Medical Systems, Cleveland, Ohio, USA

We present a method for finding tailor-made B1 field profiles. This method involves doing a Fourier series expansion of the current distribution and then finding the Fourier coefficients such that the B1 field has the desired profile. Of course, it is only possible, in general, to find a set of coefficients for an arbitrary desired field profile consistent with Maxwell's Equations. We have been successful in finding a set of coefficients that may be of interest for a SENSE coil on a half-birdcage.
13:51  **1607. Computational Comparison of Two RF Coil Configurations for SENSE Imaging**  
Alfredo Odon Rodriguez*  
¹UM Iztapalapa, Mexico, Mexico

The ultimate factor \( g \) was used to theoretically compare performance of two coil geometries for SENSE imaging. The circular SNR formula based on the quasi-static model was used, and the PERES coil SNR was calculated following the same approach. These expressions together with the ultimate factor \( g \) formula were used to compute ultimate-factor-\( g \)-vs-distance plots for comparison purposes. The PERES coil factor \( g \) can be up to 27% below that of a single circular-shaped coil. This improvement makes PERES coil a good choice for SENSE imaging. The present method strengthens the \( g \) simulation approach to evaluate coil performance for SENSE applications.

Jian-xiong Wang*, Donald B. Plewes  
¹Sunnybrook and Women's College Health Sciences Centre, Toronto, Ontario, Canada

Synopsis: An analytical approach for estimating the inductance of a surface coil as well as the mutual inductance between arbitrary shaped RF surface coils is presented. The method is motivated by the need to design customized coil geometries that closely fit the curvilinear geometry of the anatomy of interest. In these cases, the shape of the coils can be complex such that standard methods to calculate the inductance of a single coil as well as the mutual inductance among sets of coils can be cumbersome. In this work, we present a fast semi-analytic approach for this sort of task.

13:53  **1609. MRI with a 32-Element Coil**  
Cecilia Possanzini*, Marcel Wantjes¹, Marc Verheyen¹, Sander Slegt¹, Fredy Visser¹, Alun Jones¹, Johan Overweg²  
¹Philips Medical Systems, Best, Netherlands; ²Philips Research Laboratories, Hamburg, Germany

A 32-element coil was built for abdominal applications. The coil was made with a modular approach by simply repeating 16 times a 2-element Philips Flex-S coil. The elements were placed in an anterior and posterior 4x4 array with the desired field of view and minimum coupling. The first images indicated a good penetration depth of the small elements of the coil.

13:54  **1610. High Field Parallel Imaging in Rats**  
Peter Ulmann¹, Sven Junge¹, Franciszek Hennek¹, Arno Nauerth², Ioannis Panagiotelis², Wolfgang Ruhm², Juergen Hennig¹  
¹Freiburg University Hospital, Freiburg, Germany; ²Bruker BioSpin MRI GmbH, Ettlingen, Germany

This study demonstrates the successful in-vivo application of parallel high field MRI in animals. In particular, spin-echo images with different acceleration factors were acquired from a rat head at 4.7 T using a specially designed 4-element array coil and were reconstructed using the GRAPPA algorithm. The images obtained show high quality and SNR despite the accelerated acquisition. Furthermore, the penetration depth of the coil extends beyond that expected for the individual array elements.

13:55  **1611. Hardware Combiner Testing and Simulation**  
James H. Akao¹, Diana D. Spencer¹, Charles A. Saylor²  
¹MRI Devices Corporation, Gainesville, Florida, USA

A design and validation system was created for multi-channel RF hardware combiner-splitter circuits. The system includes circuit SPICE simulation and a computer driven hardware test fixture. Test results validate the simulation methodology. The system permits rapid design and evaluation of large LC combiner-splitters from given power division and phase shift requirements. The system is also used in production quality control.

13:56  **1612. SNR Gain of Cooled/Superconductor Array**  
Lian Xue¹, Lei-Ming Xie¹, Maged Kameel¹, Jaroslaw Wosik¹  
¹University of Houston, Houston, Texas, USA

It is well recognized that cryogenically cooled normal metal or high critical-temperature superconducting (HTS) surface probes can be used to significantly improve SNR when coil noise dominates in MRI system. In this work we have calculated potential SNR gain vs. number of elements in the array, which can be achieved, for the same field of view, by replacing normal metal array with either cooled to 77K copper or HTS material. For such gain we have found that maximum size of the HTS array elements are: ~2", 1.7", 1.2" and 1" at 64, 128, 200 and 300 MHz, respectively.

13:57  **1613. Design of an 8-channel Head Coil for SENSE Acceleration in 2 Directions**  
Yuji Iwadate¹, Eddy B. Boskamp², Akira Nabetani¹, Tetsuji Tsukamoto¹  
¹GE Yokogawa Medical Systems, Hino, Japan; ²GE Medical Systems, Waukesha, Wisconsin, USA

An 8-channel head coil was designed for SENSE acceleration in any direction. Using an electro-magnetic simulation, we optimized the shape of coil and detailed the geometry in terms of \( g \) factor. We determined the shape to be rectangular coil elements overlapped with others adjacent in the SI direction, placing emphasis on minimizing \( g \) factor for a reduction factor of 2 in the three directions. The SI overlap reduces the \( g \) factor in coronal or sagittal planes due to the lack of MR signal from longitudinal B1 components.
RF Special Applications

Room C-2  Thursday 13:30 - 15:30

13:30  **1614. Intermolecular Double-Quantum Coherence MR Microimaging of Pig Tail with Unique Image Contrast**

T. Hou¹, Z. Chen¹, D. W. Hwang¹, J. H. Zhong², L. P. Hwang*¹
¹National Taiwan University, Taipei, Taiwan; ²Xiamen University, Xiamen, Fujian, People's Republic of China; *University of Rochester Medical Center, Rochester, New York, USA

Image contrast in intermolecular double-quantum coherence (iDQC) imaging of a pig tail was investigated on a 7.05 T microimaging scanner. The areas under the iDQC-encode gradients in the iDQC imaging sequence were used to manipulate image contrast. When suitable imaging parameters were selected, images with unique contrast were obtained without using contrast agents. The effects of iDQC-encode gradient on image contrast were studied, and the unique contrast imposed was also shown. Experimental results demonstrated that the iDQC images have contrast fundamentally different from the conventional single-quantum coherence images.

13:31  **1615. Investigating the Characteristics of Focusing by a Coil Array under Different Conditions with Debye's Potential and Genetic Algorithm**

Wei-Hao Chang¹, Jhy-Horng Chen¹
¹Interdisciplinary MRI/MRS Laboratory, Taipei, Taiwan, Taiwan

Focusing by an array is a common scheme in various fields of engineering, and now we try to characterize the abilities of focusing by the B1 coil array in MRI. Debye’s potential and genetic algorithm are used together to simulate the B1 distribution produced by the coil array under various conditions. Results show that increasing the number of the coils always helps to focus better. On the other hand, increasing the radius of the coils or increasing the B0 strength doesn’t ensure a better performance of focusing.

13:32  **1616. Implementation of Underdetermined SENSE: Clinical Examples from Brain Imaging**

Johan S. van den Brink¹, Tom Rozijn¹, Fredy Visser¹, Koert Bloemers¹, Miha Fuderer²
¹Philips Medical Systems, Best, Netherlands

Underdetermined SENSE is a parallel imaging technique enabling scan time reductions exceeding the number of independent RF receive channels. We implemented this technique on a routine clinical MR scanner to show the feasibility of obtaining good-quality images in the brain, esp. using 3D sequences and 2D SENSE. Examples using phase-contrast venography and anatomical 3D FFE images show that reduction factors can readily exceed the number of receivers by 30-50%.

13:33  **1617. Accuracy and Reproducibility of CFD Applied to Contrast-enhanced 2D TOF MR Images of a Stenosed Carotid Artery Phantom**

Sally Bashford¹, Fadi Paul Glor², Lindsey A. Crowe¹, Pascal René Verdonck², X. Yun Xu, David N. Firmin¹, Simon A. Thom¹, Alan D. Hughes¹
¹Imperial College, London, UK; ²Ghent University, Ghent, Belgium; ³Royal Brompton Hospital, London, UK

Computational Fluid Dynamics (CFD) used for modelling complex blood flow in vivo requires accurate arterial geometry. MRI is widely used to provide this but there is concern that signal loss can cause inaccuracies. This study investigated the accuracy and reproducibility of geometric and flow parameters determined by CFD applied to MRI images of a stenosed carotid artery phantom under physiological realistic flow conditions. Comparisons of wall shear stress and reproducibility of geometry between MRI scans and computer-aided design is good although there is some loss of accuracy in the post stenotic region.

13:34  **1618. Assessment of Parallel Acquisition Techniques in Adrenal MR Imaging: Does Increased Temporal Resolution Significantly Improve Visualization of Adrenal Lesions?**

Daniel T. Boll³, Claudia M. Hillenbrand³, Jonathan S. Lewin¹, Danielle M. Seaman¹, Jeffrey L. Duerk¹, Elmar M. Merkle¹
¹University Hospitals of Cleveland, Cleveland, Ohio, USA

Conventional coil reception and parallel array acquisition methods employed in adrenal imaging were compared, and the relationship between temporal resolution and image quality was analyzed. Sequences were applied in ten healthy volunteers and ten patients with adrenal gland lesions, and images were subsequently evaluated qualitatively and quantitatively. Acceleration of single acquisition TSE sequences through parallel imaging SMASH techniques incorporating autocalibration methods (GRAPPA) was found to lead to an increase in both diagnostic power and image quality and a reduction of breathing motion artifact, while improving temporal resolution and increasing contrast.
13:35  1619. Brain Creatine Deficiency Treatment: Long Term Brain $^1$H and $^{31}$P MRS Monitoring Study Under Different Creatine Regimen

Maria Cristina Bianchi$^1$, Michela Tosetti$^2$, Vincenzo Leuzzi$^3$, Roberta Battini$^3$, Maria Grazia Alessandri$^2$, Giovanni Cioni$^2$

$^1$S. Chiara Hospital, Pisa, Italy; $^2$Stella Maris Scientific Institute, Pisa, Italy; $^3$University of Rome "La Sapienza", Rome, Italy

Brain Creatine deficiency (Cr-d) therapy relies upon a life-long Cr-administration and therefore establishing the minimum and sufficient amount of Cr-intake is fundamental. We have measured brain Cr content fluctuations in one patients with Arginine:Glycine AmidinoTransferase deficiency (AGAT-d) and in one patient with GuanidinoAcetate MethylTransferase deficiency (GAMT-d) by consecutive $^1$H and $^{31}$P MRS studies during a three years period of Cr ingestion at different doses. According our results, $^{31}$P MRS seems to be more suitable than $^1$H MRS in the treatment evaluation of brain Cr-d syndromes and the minimum Cr-therapeutic range should be included between 300-400mg/Kg/die.

13:36  1620. New FOCI Pulse with Significantly Reduced RF Power Requirements

Jun Shen$^1$, Zhengguang Chen$^1$

$^1$NIMH, Bethesda, Maryland, USA

A FOCI pulse with significantly reduced RF power deposition was proposed which incorporates the VERSE schemes into the pulse design. The time-dilation function was predefined while the adiabaticity factor was conserved in the new VERSE-FOCI scheme. The new pulse is shown to be able to operate at the same peak RF power as that of a five-lobe sinc inversion pulse of the same duration. Using the new pulse significant gain in sensitivity was observed in in vivo spin-echo echo-planar imaging which was attributed to the improved refocusing slice profile generated by the VERSE-FOCI pulse.

13:37  1621. Selective Adiabatic Population Inversion at Low RF Peak Amplitude

Lorenz Karl Mitschang$^1$, Herbert Rinneberg$^1$

$^1$Physikalisch-Technische Bundesanstalt, Berlin, Germany

A new adiabatic inversion pulse and its design principles are presented. The pulse trajectory is of composite nature. (i) A linear frequency sweep at constant rf amplitude prevails throughout the specified bandwidth. (ii) Apodization of the pulse amplitude is achieved by adiabatically tracking the isochromat at the boundary of the band along an elliptical path with constant adiabaticity parameter. The discharge into the linear sweep must occur smoothly, maintaining the constancy of the adiabaticity parameter. In comparison with the sech/tanh pulse selective inversion can be achieved at almost half the rf peak amplitude.

13:38  1622. Exact Amplitude Calibration of Hyperbolic Secant RF Pulses

Jan M. Warning$^1$, G. Bruce Pike$^1$

$^1$Montreal Neurological Institute, Montreal, Quebec, Canada

An equation for calibration of the B1 amplitude of hyperbolic secant (HS) RF pulses as a function of desired population inversion and pulse parameters was derived analytically. The equations allow for minimization of the RF amplitude necessary to guarantee a required amount of inversion, provide exact knowledge of the realized inversion efficiency and are valid for any degree of inversion, including saturation of longitudinal magnetization. They thus allow to exploit the superior selectivity of HS pulses for saturation, at amplitudes where the pulse is not adiabatic and thus requires precise calibration like conventional amplitude-modulated pulses used to that effect.

13:39  1623. Comparison of Multi-Slice Current Density Imaging in SE and GE: Phantom Experiment

Mehran Goharian$^1$, Gerald Robert Moran$^1$

$^1$McMaster University, Hamilton, Ontario, Canada

Current density imaging is a modality of MRI that enables electric current distribution imaging in conductive samples. Low Frequency Current Density Imaging uses MRI to measure the magnetic fields produced in an object using an applied current. Two sequences, SE and GE, were used to measure the current density inside a cylindrical phantom. In comparison to SE sequences, the GE images show a higher radial distribution of current around the center of the phantom except for slices at larger distances from current blocker plate where a uniform distribution was observed. The results from our phantom experiments will be presented.

Gradient Coils, Magnets, and their Subsystems

Room C-2  Thursday 13:30 - 15:30

13:30  1624. An RF Shield Comparative Study of Different Materials and Types

Daniel Weyers$^1$, Qin Liu$^1$

$^1$GE Medical Systems, Waukesha, Wisconsin, USA

An RF shield is an integral part of any MRI system. It has dual functionality, good high frequency conductivity for RF shielding and transparency to the gradient field to minimize eddy current losses. In finding an optimum tradeoff, the gradient coil impedance and RF coil Qs are usually compared for different RF shields. Compromising either performance of the RF coils or the gradient system can critically degrade the overall performance of the system. This work attempts to identify a best option among some solid, mesh and segmented RF shields.
13:31  **1625. Surface RF and Gradient Coil Set for Microscopic Skin MRI**  
Jae-Ho Han1, Yeun-Chul Ryu1, Young Gwon Kim1, Chil-Hwan Oh2, Bo-Young Choe3, Chang-Hyun Oh3  
1Korea University, Seoul, Republic of Korea; 2College of Medicine Korea University, Seoul, Republic of Korea; 3The Catholic University, Seoul, Republic of Korea  

For high resolution skin imaging, strong gradient field is indispensable. In this paper we designed and implemented a planar gradient coil for skin imaging. By this coil system we get the high resolution skin images less than 100 μm.

13:32  **1626. High Precision Current Control with Parameter Estimation in the Gradient Amplifier for MRI**  
Rixin Lai1, Xiaohua Jiang1  
1Tsinghua University, Beijing, People's Republic of China  

A digital feed forward control scheme developed for the switch-mode gradient amplifier with an H-bridge configuration is proposed in this paper to obtain gradient coil currents with fast ramp speed and low ripple level. A simplified load model based on the state vector equations is used in the feed forward controller design and a final current correction is obtained by a conventional feedback loop employing a PI regulator. Parameter estimation of the plant provides a type of self-tuning of the proposed controller. Computer-aided simulations are presented and the results indicate that the digital scheme is effective.

13:33  **1627. Vibro-acoustic Characterization of Gradient Induced Noise in a 7T MRI Scanner**  
Laurent Deschaintres1  
1MGH-NMR Center, Charlestown, Massachusetts, USA  

The vibro-acoustic behavior of a head-only Gradient Coil Assembly (GCA) installed in a 7T MRI scanner has been investigated. Various sound and vibration measurements were made and Frequency Response Functions (FRF) in the [20-4000] Hz range were derived from the system acoustic response at the isocenter of the bore. Linear swept sine input signals were used for each gradient coil. The system linearity was ensured and thus the loud gradient-induced noise of some EPI sequences could be predicted using a Finite Impulse Response (FIR) filter based model derived from the identified impulse responses.

Rostislav A. Lemdiasov1, Reinhold Ludwig1, Craig Ferris2  
1WPI, Worcester, Massachusetts, USA; 2University of Massachusetts Medical Center, Worcester, Massachusetts, USA  

A new approach for the design of gradient coils for magnetic resonance imaging is presented. The theoretical formulation involves a cost function between the deviation of the magnetic field from the desired one in the region of interest and the magnetic energy of the gradient coil. The method is applicable to an almost arbitrarily defined surface that carries the current. The problem formulation results in a set of linear equations whose solution yields discrete current elements on a specified coil surface. Numerical predictions underscore the success of this approach in terms of achieving a highly linear field and low inductance.

13:35  **1629. An Analytical Model of Gradient Coil Heating**  
Yuteng Chen1, Brian Rutt1  
1Robarts Research Institute, London, Ontario, Canada  

Gradient coil heating has become a major barrier to achieving higher spatial and temporal resolution in MR imaging. It would be ideal to predict the thermal properties of gradient coils before they are built so that improvements can be made at the design stage. We developed a method to model the temperature response of multi-layer, water-cooled gradient coils. The model is fully analytical and derived just from the known material properties and coil dimensions. Actual heating experiments were carried out to evaluate the accuracy of the model. Results prove that this model is a practical tool for gradient coil design.

13:36  **1630. An Easy to Exchange High Performance Head Gradient Insert for a 3T Whole Body MRI System: First Results**  
Ralph Kimmling1, Eva Eberlein1, Matthias Gehhardt1, Benedikt Hartinger1, Ralf Ladebeck1, Razvan Lazar2, Tim Reese2, Joerg Riegler1, Franz Schmit1, Gregory Alma Sorensen2, Van Wedeen2, Lawrence L. Wald2  
1Siemens Medical Solutions, Erlangen, Germany; 2A. A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA; 3Siemens Medical Solutions, Charlestown, Massachusetts, USA  

A dual gradient coil mode is described herein allowing use of the whole body gradient coil for whole body applications with standard uncompromised clinical performance (Gmax = 40 mT/m and SR 200 T/m/s) and use of an insertable head gradient set with significantly higher gradient performance (Gmax > 90 mT/m and SR 800 T/m/s). A strong focus was placed on the method to switch the head gradient set in and out of the magnet as this is the crucial point for routine use, i.e. the swap time should be minimal.
Design Methodology for Arbitrary Shaped Gradient Coils for MRI

Huawei Zhao¹, Wolfgang Roffmann¹, David Doddrell¹
¹The University of Queensland, Brisbane, Queensland, Australia

A new gradient coil design philosophy is presented. A hybrid numerical method has been developed and in order to demonstrate the method's applicability, an unshielded conventional gradient coil set has been designed and constructed. The method is flexible and may be applied to design a gradient coil mounted on most geometrically curved surfaces producing a linear gradient field along an appropriate axis of the magnetic field. Specific examples of such designs are given.

Vibration Analysis and Measurement of a Gradient Coil Insert in a 4T MRI

Chris Mechefske¹, Guozhi Yao¹, Carl Gazdzinski¹, Fenglin Wang¹, Brian Rutt²
¹Queen's University, Kingston, Ontario, Canada; ²Robarts Research Institute, London, Ontario, Canada

High speed switching in gradient coils operating within high magnetic field strength MRI scanners may result in high acoustic noise levels. A Finite Element (FE) model was developed to characterize the vibration properties of a gradient coil insert. Experimental modal testing in a free-free state (no constraints) shows that the FE model predicts the vibration properties extremely accurately. Vibration analysis results from the FE model with boundary constraints in place were again verified through experimental testing in a 4T MRI excited with swept sinusoidal waveforms. The predicted vibration response of the gradient coil insert was very close to that measured.

Magnet Design Considerations for Parallel Mouse Imaging

Sharon E. Ungersma¹, Greig C. Scott¹, Johannes M. van Oort², Steven M. Conolly¹
¹Stanford University, Stanford, California, USA; ²General Electric Global Research Center, Niskayuna, New York, USA

Mouse imaging is a growing sector of MRI, driven by a number of large-scale phenotyping projects to track mutagenesis in mice. One option for imaging mice is insertable RF coil arrays in large-bore magnets; this technique may image up to 16 mice in parallel. Here we show that a mouse scanner with a long, narrow homogeneous volume that can accommodate 16 mice end-to-end uses significantly less conductor mass than a design with a 20-cm DSV that fits a 16 mouse RF coil hex array. The long, narrow design also allows possible improvements in cryostat construction, gradient strength, and RF shielding.

Multi-channel External Receiver for Multi-Animal Imaging

H. Douglas Morris¹, A. Scott Chesnick¹, Jerzy Bodurka²
¹National Institutes of Health, Bethesda, Maryland, USA

A consequence of progress in genetic research is the need to evaluate the expression of a genetic modification in the developing or adult animal. MRI has been shown to be an excellent method for phenotyping the mouse, the mammalian genomic model of choice. The exponential increase in recent years of mouse genome experimentation requires a concomitant increase in the ability to rapidly image many samples. We have constructed a direct digital receiver system capable of simultaneous imaging 4 mice on a standard MRI scanner.

Phantom Fluids for High Field MR Imaging

Timothy Skloss¹
¹GE Medical Systems, Waukesha, Wisconsin, USA

Filler fluids for large, voidless phantoms to be used at high magnetic field strengths (>3T) will be presented. These novel fluids are adjustable in T1, spectrally pure, chemically inert, low viscosity, thermally and chemically stable, and have a low dielectric constant relative to water which makes them ideal for calibrating large FOV, high field MRI imaging systems.

Measurement of Field Variations Associated With Magnet Temperature Changes

AbdElMonem Mohamed El-Sharkawy¹, Ergin Atalar²
¹Johns Hopkins University, Baltimore, Maryland, USA

The stability of the main magnetic field is a major concern for the accuracy of MR procedures that are sensitive to phase errors, such as MR thermometry. In this work, we measure and analyze, in a systematic procedure, the stability of the main magnetic field for an MR system. Both temporal and spatial variations in the field were detected and the main source for these variations was attributable to temperature changes in the magnet system. This procedure allows predetermining the expected errors that result from magnetic field variations (especially for old magnet designs) and for devising the appropriate correction techniques.

A 180mT Pulsed Homogeneous Magnet for Prepolarized Knee MRI

Steven Michael Conolly¹, Greig Cameron Scott¹, Thomas Grafendorfer¹, Albert Macovski¹
¹Stanford University, Stanford, California, USA

Low field MRI following pre-polarization (e.g., hyperpolarized gas, prepolarized MRI) offers the same SNR as high field MRI, provided the reception frequency is high enough that body noise dominates coil noise. Body noise dominance has been experimentally demonstrated at 5 MHz in a human head. Here we present an inexpensive homogeneous magnet design that can operate above 7 MHz MRI frequency, which could improve the SNR of human wrist and knee images by a factor of up to 4 relative to our current 1.1 MHz prepolarized MRI scanner.
Takeaki Kurimoto¹, Takeshi Furuya¹, Sadanori Tomiha¹, Toru Shirai¹, Yoshimasa Matsuda¹,
Tomoyuki Haishi², Shin Utsuzawa³, Katsumi Kose¹, Hiroshi Yoshioka¹
¹University of Tsukuba, Tsukuba, Ibaragi, Japan; ²MR Technology Inc., Tsukuba, Ibaragi, Japan; ³Brigham and Women's Hospital,
Boston, Massachusetts, USA
Two compact MRI systems were developed for hand imaging. The first system used a 0.21 T, 25 cm vertical-gap permanent magnet and the second system
used a 0.20 T, 16 cm horizontal-gap permanent magnet. These magnets were installed in compact electromagnetic shield rooms (3.8 and 1.8 m²) and
combined with compact MRI consoles. The total installation spaces were about 6 and 4 m². MR images of hands acquired for several athletes and volunteers
demonstrated usefulness of the systems.

13:45 1639. Simplified One Port Noise Measurement System
Mark Winebrand¹, Jovan Jevtic¹, Velibor Pikelja¹
¹IGC-Medical Advances Inc., Milwaukee, Wisconsin, USA
There is a strong need for the direct measurement of noise in MRI coils. The “One Port Noise Measurement System”, primarily intended for operation at
10 – 300 MHz, has been developed for this purpose. The system distinguishing features are: it measures absolute noise power, it uses the standard and
inexpensive equipment, it is intended for the noise measurements of any one port device (such as a coil) with arbitrary and known noise source impedance,
it is fast and simple to use. The system measurement accuracy has been estimated to be < 0.5 dB.

13:46 1640. A Design Method for Asymmetric and Symmetric, Planar Gradient and Shim Coils
Larry Forbes¹, Stuart Crozier²
¹University of Tasmania, Hobart, Tasmania, Australia; ²University of Queensland, Brisbane, Australia
New design methodologies for planar shims and gradients are introduced. These are based on a novel regularization scheme and result in a design capability
for shielded, asymmetric and symmetric, streamline shims and gradients for use in open or planar MRI systems. Example designs are presented.

13:47 1641. Planar Surface Gradient Coil for Vertical B₀-Field
Frank Resmer¹, Hugh Seton¹, James M. S. Hutchison¹
¹Aberdeen University, Aberdeen, Grampian, UK
We describe a new design of planar surface gradient coil (SGC) for use in a 0.01 T vertical field MRI system. The SGC has been developed in an attempt to
reduce eddy current effects, increase gradient efficiency and improve patient access. The SGC coils are wound from enamelled copper wire and are held in
place between a pair of polycarbonate discs. The measured performance agrees closely with simulations and the coil has successfully been used to image
small test objects. We hope to combine the SGC with a surface RF coil to image superficial regions of the body.

Computational Electromagnetics
C-1 & C-2 Lobby  Monday 14:00 - 16:00

14:00 1642. Improving B₁ Uniformity in a Birdcage Coil at 7T by Offsetting Along the Z Axis
Graeme McKinnon¹, Eddy Boskamp¹
¹GE Medical Systems, Waukesha, Wisconsin, USA
In the course of numerically comparing a high-pass birdcage and a TEM resonator, with respect to head imaging at 7T, it was noticed that the B₁+
uniformity of the TEM was superior to that of the birdcage when both coils were centered on the head. Here it is shown how the B₁+ uniformity of the
birdcage can be improved by offsetting it in the superior direction.

14:01 1643. Optimization of RF Coils for High Field Imaging: Why the Head is Different Than Symmetrical Phantoms
Tamer Selim Ibrahim¹
¹The University of Oklahoma, Norman, Oklahoma, USA
In this work we evaluate multiple port excitations to distinguish the difference between symmetrical and/or regular shaped phantoms and anatomical
structures such as the Human head. The evaluations are done in multiple coils and phantoms for imaging at 4.7 and 8 Tesla. While the results demonstrate
the ineffectiveness of this technique when dealing with symmetrical structures, it shows tremendous potential for the irregular shaped cases. It is
demonstrated that the standard 4-port excitation is the optimal configuration for symmetrical/regular shaped phantoms while unique phases and magnitudes
are obtained for the human head models.
A three-dimensional model of the B0 distribution in the head of an adult rat is presented. Static field distortions seen in model correlate well with signal loss in T2*-sensitive images of the rat brain.

A detailed theory and calculation are given for the quality, or Q factor, of a lossy dielectric cylinder enclosed in a long cylindrical resonator of bird cage or TEM type. Plots of magnetic flux illustrate the transition from an under- to an over-damped condition. At low damping, the dielectric experiences an upward frequency shift inside a shielded resonator.

The theory of radiation damping in NMR reception is recast in terms of the reciprocity principle, and inconsistencies in the conventional formulation are pointed out.

The precise evaluation of RF coil-tissue interactions and the electromagnetic fields inside biological samples is becoming an increasingly critical design requirement for high-field MRI engineering. Suitable phantom-based analysis is essential to coil design and evaluation. This paper presents an analysis model of RF coils in the presence of a multi-layered lossy sphere, roughly resembling the human head. The model advantage is that the fields can be calculated relatively quickly while maintaining realistic overall loading. In this model, the EMFs are handled by the dyadic Green’s function and the coil currents are evaluated by MoM. Test examples show the model capability.

Suitable phantom-based modelling and analysis is essential to MRI coil design and evaluation. This paper presents an analysis model of MRI coils in the presence of a multi-layered lossy sphere, roughly resembling the human head. The field calculation is based on a Debye Potential (DP) formulation and deals with a symmetric configuration in which the source is a circular loop carrying a harmonic-formed current at any frequency. Test examples have shown the capability of the proposed model.

Electromagnetic simulation and electric circuit analysis are applied to the tuning and matching requirements analysis of RF coils. Electromagnetic simulation is performed using the Transmission-Line Modelling method to simulate RF coils in the free-ringing condition, from which their frequency response and equivalent lumped-element circuit components are determined. Equivalent lumped-element electric circuit representations are derived and electric circuit analysis is applied for both capacitive and inductive matching schemes to determine the tuning and matching requirements. Experimental comparisons are performed with an agreement of < 3 pF for variable tuning and matching capacitances, thus enabling component selection and validating the methods presented.

Echo-planar imaging of the lower frontal lobe of the human brain is difficult because of tissue susceptibility effects. Magnetic field variations on the order of tenths of parts per million or more occur that cause image warping and signal dropout. This work combines resistive shims with passive shims and a user-defined mask to improve magnetic field uniformity and echo-planar image quality in the lower frontal lobe.
The research comprises of a feasibility study to investigate whether it is possible to perform reliable FDTD $B_1^+$ field simulations for a standard clinical MR transmit body coil. For this purpose $B_1^+$ measurements and FDTD $B_1^+$ calculations are compared for a heterogeneous cylindrical split phantom placed inside the body coil of a standard 1.5 T clinical scanner. It is concluded that there is a good qualitative and a fair quantitative correlation. In the near future this work will be extended towards $B_1^+$ measurements and FDTD $B_1^+$ calculations on a human cadaver.

MR Safety and Bioeffects

C-1 & C-2 Lobby  Wednesday 13:30 - 15:30

13:30  **1652. Use of Resistances and Resistive Leads: Implications on Computed Electric Field and SAR Values.**

Leonardo M. Angelone$^1$, Giorgio Bonmassar$^2$

$^1$Massachusetts General Hospital, Charlestown, Massachusetts, USA

We investigated the changes of Specific Absorption Rate on human tissues due to resistive leads and resistances in MRI. Values of commercially available fibers were considered in the simulations with a high-resolution head model. Both intracranial electrode/lead and 31 electrodes/leads were used. Results showed that the leads modified the electric field, with increases of peak 1g averaged SAR up to 15 times compared to the no-electrode model. Such increase depended on the type of leads (metallic or resistive) but did not depend on the presence of a 10KOhm resistance between electrode and lead.

13:31  **1653. Specific Absorption Rate: A Specious Dosimeter of MRI-Related Heating for Metallic Implants.**

Kenneth B. Baker$^1$, Jean Tkach$^1$, John Nynhuys$^2$, Michael Phillips$^2$, Frank G. Shellock$^3$, Ali R. Rezai$^1$

$^1$The Cleveland Clinic Foundation, Cleveland, Ohio, USA; $^2$Purdue University, West Lafayette, Indiana, USA; $^3$University of Southern California, Los Angeles, California, USA

This in vitro study reveals significant differences in the amount of MRI-related heating per unit of whole body averaged SAR, as measured using fluoroptic thermometry, of a deep brain stimulation implant across two different 1.5-T MR systems using transmit/receive body RF coils. Although SAR often is used for safety recommendations related to performing MRI in patients with conductive implants, the data suggest that SAR-based recommendations related to some conductive implants must be system, and perhaps software-version, specific. Indeed, modeling systems for SAR calculation vary not only between manufacturers but also constitute an evolving process within a given manufacturer’s system.

13:32  **1654. Assessment of Magnetic Field Interactions at 1.5- and 3-Tesla for Implantable Pulse Generators and Receivers Used for Neurostimulation Systems.**

Kenneth B. Baker$^1$, John Nynhuys$^2$, Greg Hrdlicka$^1$, Jean Tkach$^1$, Frank G. Shellock$^3$, Ali R. Rezai$^1$

$^1$The Cleveland Clinic Foundation, Cleveland, Ohio, USA; $^2$Purdue University, West Lafayette, Indiana, USA; $^3$Medtronic, Inc., Minneapolis, Minnesota, USA; $^4$University of Southern California, Los Angeles, California, USA

Measurements of magnetically induced displacement force and torque were determined for ten devices (seven implantable pulse generators [IPG] and three radio-frequency receivers) used for neurostimulation systems in 1.5- and 3-Tesla MR systems. Displacement force was assessed using the deflection angle test at various positions relative to the bore axis. Torque was determined with each device placed along its three orthogonal axes on a specially constructed turntable. Depending on position and orientation, three IPGs exhibited force/torque interactions that were greater than that experienced by the device in gravity at rest. All three RF receivers exhibited substantial translational attraction and torque.

13:33  **1655. In Vitro MR Evaluation of Implantable Electrical Device Heating Trends at 1.5T.**

Stephen G. Hushek$^1$, Heidi Prather$^2$, Damon Black$^2$, Tracy Cameron$^2$

$^1$Norton Hospital, Louisville, Kentucky, USA; $^2$Advanced Neuromodulation Systems Inc., Plano, Texas, USA

Heating of implantable electrical devices in a 1.5T MR scanner was examined in vitro using a head-torso phantom filled with gel, which replicates the thermal and electrical properties of body tissue in the 64MHz MR environment. Temperature changes were monitored using a fiberoptic thermometry system. The effect of the MR environment on heating was magnified by maximizing the SAR levels. Heating patterns were observed to be a function of lead and device position, insulation/wire ratio, lead length, loop location, and loop quantity.

13:34  **1656. Metallic Intraspinal Catheters in MRI: A Feasibility Study.**

Jens-Christoph Georger$^1$, Volker Martin Tronnier$^2$, Sabine Heiland$^2$

$^1$University of Heidelberg Medical Center, Heidelberg, Germany

The goal of this study was to evaluate and minimize possible hazards for patients with implanted metallic intraspinal catheters and subcutaneously implanted pumps for continuously spinally delivered pain medication. Image quality was assessed as well. Catheter and pump were placed in a NaCl-solution filled phantom. The measurements of temperature were performed during scanning of different clinical standard sequences. The results show that MR examinations are safe if the patient's spinal cord is positioned along the scanner's z-axis. The images don't lose diagnostic value and control of the catheter’s position in the spinal cord is possible.
13:35  1657.  MR Safety Evaluations of Large External Fixation Frames and Clamps

Roger Luechinger¹, Peter Boesiger²
¹University and ETH, Zurich, Switzerland

A with respect to MR safety redesigned large external fixation systems designed for management of fractures and lesions of the upper or lower extremities and pelvis have been evaluated for MR safety aspects. Accelerations induced by magnetic forces on carbon rods, schanz screws and five different clamps from Synthes stayed below 3.5ms⁻² and no torque effects could be seen. Heating effects at the screw tip of a knee and a pelvic frame where up to 4.1 C.

13:36  1658.  Neurostimulation Systems Used for Deep Brain Stimulation: Factors Impacting MRI-Related Heating at 1.5- and 3-Tesla

Kenneth B. Baker¹, Jean Tkach¹, Frank G. Shellock², John Nyenhuis³, Ali R. Rezai¹
¹The Cleveland Clinic Foundation, Cleveland, Ohio, USA; ²University of Southern California, Los Angeles, California, USA; ³Purdue University, West Lafayette, Indiana, USA

The purpose of this work was to characterize factors that impact MRI-related heating of neurostimulation systems used for deep brain stimulation. Experiments were performed using a transmit/receive body and head (1.5-Tesla) as well as a head-only (3-Tesla) MR system. Heating at the level of the intra-cerebral electrode was significantly reduced (~70%) through the placement of small-diameter loops at the level of the skull. The amount of RF-induced heating at the electrode also varied markedly as a function MR landmark. It may be possible to use stereotyped lead configurations to reduce heating potential and improve patient safety during MRI.

13:37  1659.  A Noise Attenuating Device for MR Imaging in Infants

Wen-Ching Liu¹, Nino Badridze², Sarah Paterson¹, Judy Flax¹, Susan C. Feldman¹, April A. Benasich²
¹UMDNJ-NJMS, Newark, New Jersey, USA; ²Rutgers University, Newark, New Jersey, USA

The strong acoustic noise generated from a MR scanner creates the potential for severe hearing damage in infants, due to their higher sensory threshold. We developed a noise-attenuating device, which includes a helmet, earmuffs, earplugs and a body wrap to be worn by infants during the MR imaging. In this study, we assessed the noise reduction achieved with our devise in a 1.5T scanner. Preliminary results show that the helmet-earmuff combination alone reduced the noise levels by about 30 to 40 dB. It is suggested that the noise reduction for the entire device may reach ~50 dB or above.


Shashikant R. More¹, Teik C. Lim¹, Christy K. Holland³, Jing-Huei Lee¹
¹University of Cincinnati, Cincinnati, Ohio, USA

This paper presents the results of a series of space-time-frequency sound pressure level measurements to characterize the acoustic noise response of a 4T magnetic resonance imaging scanner operating with echo planar imaging pulse sequences having trapezoidal waveforms. The study is intended to aid in the future development of active/passive noise control measures. The temporal and spectral analysis of the measured data reveals the existence of harmonics, non-harmonics and broadband noise characters. The frequency content, loudness levels and spatial distribution of the MRI sound field are also affected by numerous scan parameters including the echo time and slice orientation.

13:39  1661.  Monitoring of Cardiac Electrophysiology After Injection of Gadobenate Dimeglumine: Intra-Individual Comparison with Placebo in Healthy Volunteers and Patients with Cardiovascular Disease

Gianpaolo Pirovano¹, Daniel Goodman², Usha Halemane¹, Carole Venetianer¹, Ningyan Shen¹, Miles Kirchin³
¹Bracco Diagnostics Inc., Princeton, New Jersey, USA; ²Covance Central Diagnostics, Reno, Nevada, USA; ³Bracco Imaging SpA, Milan, Italy

24 healthy volunteers and 23 patients with CAD received by single intravenous injection in randomized crossover fashion 0.2 mmol/kg Gd-BOPTA and saline, separated by ~72h. Twelve-lead ECG monitoring was performed from 3h pre-dose until 24h post-dose with acquisition of continuous 10-second ECGs. Evaluation by automated read and blinded cardiologist revealed no differences between placebo and Gd-BOPTA concerning effects on QTc interval or other ECG parameters. Correction for heart rate was best achieved on an individualized basis rather than by means of Bazett’s formula. 0.2 mmol/kg Gd-BOPTA has no detrimental effect on cardiac electrophysiology in healthy volunteers or patients with CAD.

13:40  1662.  Wave Behavior in Phantoms at 11.1 Tesla

Barbara L. Beck¹, Kelly A. Jenkins¹, Jeffrey R. Fitzsimmons¹
¹University of Florida, Gainesville, Florida, USA

B1 field inhomogeneities at high magnetic field strengths may be due to wave behavior in the sample. As the sample size and static magnetic field strength increase, the wave effects become more significant. In addition, electrical properties of the sample affect the wave behavior within the sample and the resultant B1 field. This study looks at B1 field inhomogeneities in cylindrical phantoms of varying size and electrical properties at 11.1T (470MHz). Specifically, the bottles range in size from 60mL to 2L, and are filled with distilled water, saline, or a solution equivalent to average brain tissue at 470 MHz.
13:41 1663. Effects of Paramagnetic Structures with Simple Geometry on the Magnetic Field Distribution: A Combined Numerical and Experimental Study
Philipp Mertens1, Bernd Mueller-Bierl1, Juergen Machann1, Guenter Steidle1, Gunther Helms1,
Matthias Erich Bellemann2, Fritz Schick2
1University Clinic, Tuebingen, Baden-Württemberg, Germany; 2University of Applied Sciences, Jena, Thuringia, Germany

Different magnetic susceptibility of materials or tissue compartments is the reason for the occurrence of fast signal dephasing and artifacts in MRI. In numerical and experimental examinations, field effects due to different susceptibility of simple geometrical structures (plates) were investigated to estimate the influence of geometrical parameters and the interaction of those parameters.

13:42 1664. Observed Issues in Predicting Peripheral Nerve Stimulation Caused by Gradient Switching
Geran Peeren1, Jan van Eggermond1, Jouke Smink1, Hans Engels1, Paul Harvey1
1Philips Medical Systems, Best, Netherlands

The average PNS threshold level was determined in order to comply with the second edition of the IEC 60601-2-33 safety standard. The experiments were performed with the latest generation gradient hardware (88 mT/m, 240 T/m/s). The conclusion is that even when the onset of sensation threshold is known for a volunteer, for a particular scan the accuracy of predicting PNS is about 50-150%. Nevertheless, the effective usage of a model and the predetermined PNS threshold levels has increased the maximum allowed gradient output on average significantly as compared with the default values given in the IEC standard.

13:43 1665. RF Heating Assessment through Electric Field Measurements and Computational Modeling in Phantoms
Alayar Kangarlu1, Anila Patha2, Vanishree Ranganath2, Tamer Selim Ibrahim2
1The Ohio State University, Columbus, Ohio, USA; 2University of Oklahoma, Norman, Oklahoma, USA

RF heating is particularly aggravated in magnetic resonance imaging (MRI) scanners operating at high fields (>3T) due to the inhomogeneous RF distribution. Considering that the RF heating is primarily caused by the attenuation of the RF E-field, a direct measurement of such field along with its computation using computational electromagnetics modeling will provide a robust means for assessment of such RF thermal effect. We have built a probe and used it to measure the E-field of the RF within a phantom and also used computational techniques to calculate the same quantity.

13:44 1666. MR Thermal Imaging at 3T – Potential SAR Monitoring Tool?
Yong Zhou1, Julia Klinge1, Thomas G. Grist2
1GE Medical Systems, Waukesha, Wisconsin, USA; 2University of Wisconsin-Madison, Madison, Wisconsin, USA

We demonstrate the feasibility and advantage of using the water proton resonance frequency (PRF) shift based MR thermal imaging technique to measure temperature change in a 3T scanner. The accuracy is adequate to monitor SAR related heating and can provide a more quantitative measure of specific absorption ratio (SAR) and potentially leads to better thermal models and overcome the SAR limitations that have hampered some of the 3T imaging protocols.

13:45 1667. Specific Absorption Rate (SAR) for a Transceive Shoulder Surface Coil at 3T using Finite Difference Time Domain (FDTD) Electromagnetic Simulations
Richard T. Goldberg1, David M. Peterson1, James J. Caserta1, Jeffrey R. Fitzsimmons1
1University of Florida, Gainesville, Florida, USA; 2Analog Devices, Inc., Greensboro, North Carolina, USA

The local SAR effects of a transceive shoulder coil at 3 Tesla were studied using a finite difference time domain simulation method. The results show the number of slices that can be made with a gradient, spin and fast spin echo sequence for a typical T1 sequence with a TR of 600ms.

13:46 1668. Theoretical and Experimental Investigation of the Relationship among SAR, Tissues and Resonant Frequencies in MRI
Chunsheng Wang1, Jing Yuan1, Peng Qi1, Gary X. Shen1
1The University of Hong Kong, Hong Kong, People's Republic of China

The SAR of muscle, brain and bone are investigated theoretically and experimentally. The average SAR(s) of these three tissues at 0.5T, 1.5T and 3T are simulated by finite difference time domain (FDTD) method. The SAR of muscle, brain and bone increase 7.49 folds, 10.87 folds and 12.92 folds respectively when the field increases from 0.5T to 3T. The SAR of muscle is 1.72-fold over brain and 8.74-fold over bone at 1.5T. Experiments have been carried out to obtain SAR using phantoms to simulate human tissues at 1.5T. The experiment results agree with the simulation well and within difference of 5%.
13:47  **1669. Resistive Tapered Striplines (RTS) Lower SAR in Electrophysiology Recordings during MRI**

Giorgio Bonmassar
1Massachusetts General Hospital, Charlestown, Massachusetts, USA

A purely resistive stripline lead is introduced to reduce the Specific Absorption Rate (SAR) increase due to the presence of electrodes/leads in electrophysiological measurements during MRI. Discontinuities in the resistivity profile of the stripline introduce high-frequency inductive impedance that does not affect the quality of the low-frequency recordings. The changes in SAR introduced by the RTS are studied using the finite-difference time-domain (FDTD) algorithm on a spherical phantom that models the human head. The FDTD simulations predict a drastic lowering of the whole-head SAR when using RTS Vs. conventional resistive carbon fibers.

**Hyperpolarized Helium**

C-1 & C-2 Lobby  Tuesday 13:30 - 15:30

13:30  **1670. High-Resolution Diffusion and Ventilation MRI: Hyperpolarized Xe-129 versus He-3 in a Large Animal Model**

Jaime Filipe Mata1, Klaus Hagspiel1, William Tobias1, James Wang1, Gordon Cates1, Talissa Altes1, Andrew Reish1, Kai Ruppert1, James Broekeman1, John Mugler III2

1University of Virginia, Charlottesville, Virginia, USA; 2Advanced MRI Technologies, Sebastopol, California, USA

Higher polarizations will make Xe-129 the likely future of hyperpolarized-gas MR imaging. It is also theoretically plausible that the Xe-129 ADC may be more sensitive to early disease when structural changes are on a smaller scale because of xenon’s lower diffusion coefficient. This project was designed to compare the potential of high-resolution ventilation and diffusion MRI using hyperpolarized Xe-129 at the current polarization levels of 10-20% in a large animal to hyperpolarized He-3.

13:31  **1671. MR Imaging of Hyperpolarized 129Xe and 3He: Sequential In Vivo Lung-Imaging of the Same Subject and Simultaneous Imaging of Phantoms**

Wolfgang Kilian1, Guido Narberhaus1, Frank Seifert1, Herbert Rinneberg1

1Physikalisch-Technische Bundesanstalt, Berlin, Germany

Due to the lower MR signal obtained from hyperpolarized 129Xe (HpXe) compared to hyperpolarized 3He (HpHe) fewer human MR studies with HpXe have been performed up to now. However due to the solubility of xenon in blood and tissue and its lower diffusion coefficient HpXe-MRI might be of additional diagnostic value. To show the feasibility of combined 3He/129Xe lung-imaging with the apparatus available, in vivo lung-images using HpXe and HpHe on one healthy subject were acquired on different occasions. Furthermore, a simultaneous 3He/129Xe-sequence was implemented and tested using glass bulbs filled with HpHe and HpXe.

13:32  **1672. A Comparison of Hyperpolarized 3He MR Imaging and Krypton Scintigraphy in Healthy Volunteers and COPD Patients**

Trine Stavngaard1, Lise Vejby-Søgaard1, Lars G. Hanson1, Jann Mortensen2, Jörg Schmiedeskamp3, Michael Wolf4

1Danish Research Centre for Magnetic Resonance, Copenhagen, Denmark; 2Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; 3University of Mainz, Mainz, Germany

Hyperpolarized 3He MR imaging provides regional information of the lung ventilation. This kind of information is also obtained with scintigraphic methods, however with poorer resolution. In this study we compare hyperpolarized 3He MRI and 81m Krypton scintigraphy for 25 subjects (patients with chronic obstructive pulmonary disease and lung healthy). Visual score of the severity of lung defects agreed fairly well for the two methods, however for the right lung the hyperpolarized 3He MRI scored significantly higher than the 81m Krypton scintigraphy. The percentage of non-ventilated lung estimated by the two methods correlate well.

13:33  **1673. 3He-MRI in a European Multicenter Trial in COPD and Emphysema "PHIL"**

Klaus Kurt Gast1, Anja Dahmen1, Claus-Peter Heussel1, Alexander Biedermann1, Joerg Schmiedeskamp2, Jim M. Wild1, Robert A. Lawson3, Niell Woodhouse3, Mills Gary1, Trine Stavngaard1, Asger Dirksen1, Lise Vejby-Søgaard1, Hans-Ulrich Kauczor2, Edwin J. R. van Beek1

1Klinikum der Johannes Gutenberg-Universitaet, Mainz, Germany; 2Universitaet Mainz, Mainz, Germany; 3Royal Hallamshire Hospital, Sheffield, UK; 4Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark; 5Gentofte University Hospital, Hellerup, Denmark; 6Hvidovre Hospital, Hvidovre, Denmark; 7German Cancer Research Center, Heidelberg, Germany

To investigate the usefulness of 3He-MRI in patients with COPD and pulmonary emphysema due to alpha-1-antitrypsin deficiency, a total of 160 individuals with and without these kinds of lung disease shall be included into the study in three European study centers. Spin density measurements, diffusion weighted and dynamic cine-imaging are acquired. So far, imaging has been successfully performed in 72 subjects. The evaluated individuals showed an average ADC of 0.181 in absence of lung disease, 0.279 in COPD and 0.264 in alpha-1-antitrypsin deficiency. Inclusion of patients as well as evaluation of data are ongoing.
Hyperpolarized gas imaging opens the possibility of generating maps of the spatial distribution and time evolution of intrapulmonary oxygen partial pressure, pO2, since the T1 of hyperpolarized gas in the lung is directly proportional to pO2. Early implementations required multiple breath holds, while a more recent implementation requires only a single breath hold, but both techniques are burdened by the requirement to separate T1 decay from the decline of the longitudinal magnetization due to RF consumption. We have developed a technique that can acquire detailed T1, and thus pO2, maps by obviating the need to accurately determine the B1 field.

Regional alveolar oxygen partial pressure and regional oxygen depletion rate are important markers for comprehensive assessment of lung function. We demonstrate a single-acquisition technique to extract these parameters from hyperpolarized gas MRI. We tested the technique on a phantom and a Yorkshire pig. The results indicate comparable accuracy to the established double acquisition technique with the advantages of using half the amount of polarized gas and greater ease of use.

Regional alveolar oxygen partial pressure and regional oxygen depletion rate are important markers for comprehensive assessment of lung function. We hypothesize that hyperpolarized 3He MR measurements of regional ventilation may provide a sensitive measure of the local destruction caused by emphysema and thus may play a role in the early detection of emphysema. We have developed a rat emphysema model to test this hypothesis.

Emphysema is a common disease that is an increasing cause of morbidity and mortality worldwide. There is evidence to suggest that the early detection of emphysema may play an important role in reversing this trend. We hypothesize that hyperpolarized 3He MR measurements of regional ventilation may play a role in the early detection of emphysema. We have developed a rat emphysema model to test this hypothesis.

Early detection of asthma could play an important role in preventing this pulmonary disorder at an early stage. In this work, we hypothesize that hyperpolarized 3He MR measurements of regional ventilation could function as a sensitive marker for both early detection of asthma and the development of therapeutic strategies to combat the disease. A murine model of airway hyper-responsiveness is used to test this hypothesis.

We report on a low field method that uses a fast repetition CPMG sequence to accurately track global O2 partial pressure in the human lung. The technique takes advantage of reduced tissue susceptibility gradients at low field, as well as the negligible power deposition at low frequency. Results of experiments are reported. Data simulations show that with a reasonable increase in SNR these measurements could be made prior to a regular imaging sequence all within a single breath hold.

We describe low-field magnetic resonance experiments that probe the breakdown of the high-field approximation wherein components of inhomogeneous magnetic fields (i.e. ‘gradient fields’) directed perpendicular to the homogeneous (i.e. static) magnetic field are ignored. Effectively, these experiments involve measuring the apparent diffusion coefficient of low-pressure 3He gas under a broad range of conditions. Our data suggest that recent investigations of low-field polarized noble gas diffusion in human lungs have been carried out in a regime that is consistent with the high-field approximation.
13:40 **1680. Modelling of Air Flow in the Human Airways Using Computational Fluid Dynamics and Dynamic Hyperpolarized $^3$He MRI**

Bindi Brook$^1$, Andrew Swift$^1$, Martyn NPaley$^1$, Larry Kasuboski$^2$, Stan Fichele$^1$, Neil Woodhouse$^1$, Keith McCormack$^1$, Rod Hose$^1$, Edwin Jr van Beek$^1$, Jim M. Wild$^1$

$^1$University of Sheffield, Sheffield, Yorkshire, UK; $^2$Philips Medical Systems, Cleveland, Ohio, USA

Ultrafast imaging of 3He gas has been shown to provide insight into ventilation dynamics in human lungs. In this work we use quantitative time resolved radial projection imaging of 3He to make preliminary validations of computational fluid dynamics (CFD) models of gas flow in the human lungs. The results show good agreement with CFD flow models in the major airways of healthy normals in the inspiratory phase where depolarization due to oxygen can be discounted as a source of signal loss.

13:41 **1681. Improving the Quality of 3D Hyperpolarized Gas Images using Feedback-Controlled Flip-Angle Evolution**

G Wilson Miller$^1$, Talissa A. Altes$^1$, James R. Brookeman$^1$, Eduard E. de Lange$^1$, Jaime F. Mata$^1$, John P. Mugler III$^1$

$^1$University of Virginia School of Medicine, Charlottesville, Virginia, USA

A 3D isotropic Cartesian data set is desirable for lung ventilation imaging using hyperpolarized gas. To make 3D acquisitions practical, techniques must be developed which make efficient use of the available magnetization to yield the maximum image SNR for a given dose of hyperpolarized gas. We demonstrate a method that combines variable flip angles with a feedback algorithm to generate 3D images of superior quality to standard constant flip angle acquisitions.

13:42 **1682. Regional Lung Perfusion Mapping Using Hyperpolarized $^3$He MRI and Validation to Microsphere**

Masaru Ishii$^1$, Martin C. Fischer$^2$, Jiangsheng Yu$^2$, Zebulon Z. Spector$^2$, Kiarash Emami$^2$, Thomas Connick$^2$, Jae Han$^2$, Michelle Law$^2$, David Lipsort$^2$, Rahim R. Rizi$^2$

$^1$Johns Hopkins University, Baltimore, Maryland, USA; $^2$University of Pennsylvania, Philadelphia, Pennsylvania, USA

Noninvasive measurements of regional pulmonary perfusion are of great importance and interest to pulmonologists and respiratory physiologists. We hypothesize that hyperpolarized (HP) 3He MRI can be used to determine regional pulmonary perfusion and validate our supposition in a porcine animal model. HP 3He results were compared to those obtained using microspheres a gold standard measure of pulmonary perfusion. The success of this technique suggests that it could play an important role in diagnosing lung disorders with perfusion defects.

13:43 **1683. Short- and Long-range Diffusivities of $^3$He in Healthy and Emphysematous, Excised Human Lungs**

Jason C. Leawoods$^1$, Dmitry A. Yablonskiy$^1$, Cliff K. Choong$^2$, Jonathan Wong$^2$, Kiimaki Chino$^1$, John A. Pierce$^1$, Joel D. Cooper$^1$, Mark S. Conrad$^1$

$^1$Washington University, St Louis, Missouri, USA; $^2$University of British Columbia, Vancouver, British Columbia, Canada

Short- and long-range diffusivities of hyperpolarized $^3$He gas ($D_{msec}$ and $D_{sec}$, measured over ms and s time scales, respectively) were measured in one healthy and seven emphysematous, excised human lungs. $D_{msec}$ was eleven times smaller in healthy lung than $D_{sec}$, with increased restriction reflecting tortuous paths required to navigate long distances in lung. In emphysema $D_{sec}$ is substantially increased over measurements in normal lung, with some regions near 0.88 cm$^2$/s (a 50-fold increase). Comparison of $^3$He diffusivities to histologic measurements of surface area-to-volume revealed inverse relationships; this is the first time such comparisons have been performed in human lungs.

Hyperpolarized Xenon

C-1 & C-2 Lobby  Tuesday 13:30 - 15:30

13:30 **1684. Estimating the Longitudinal Decay Time of $^{129}$Xe in Rat Brain after Perturbing Cerebral Blood Flow**

Atsushi Wakai$^1$, Jeff Kershaw$^1$, Yasushi Kondoh$^2$, Kazuhiro Nakamura$^1$, David Wright$^1$, Iwao Kanno$^2$

$^1$Akita Industry Promotion Foundation, Akita, Japan; $^2$Akita Research Institute of Brain and Blood Vessels, Akita, Japan

The cerebral blood flow of rat is manipulated to estimate the longitudinal decay time of $^{129}$Xe in rat brain. The decay time was estimated to be 37 ± 13 s and the global flow was 91 ± 30 ml blood/100 g brain/min.

13:31 **1685. An Investigation of the Pipeline Materials for Continuous Hyperpolarized $^{129}$Xe Gas Imaging**

Moyoko Saito$^1$, Takashi Hiraiga$^1$, Mineyuki Hattori$^1$, Toshiharu Nakai$^1$

$^1$National Institute of Advanced Industrial Science and Technology, Ikeda, Osaka, Japan

In order to establish continuous hyperpolarized gas imaging technique, the effect of the plastic metal materials used for a gas pipeline on the MR signal intensity was investigated. Five stainless steel tubes prepared with different passivation processes were compared. The film passivated by iron fluoride maintained the hyperpolarization at the highest level, whereas that passivated by chromium oxide maintained least. Stainless steeling tube with appropriate passive film may be a useful alternative to a Pyrex glass pipeline.
**13:32 1686. Matching Experimental Data to a 1D $^{129}$Xe Gas Exchange Model**  
Kai Ruppert$^1$, Jaime Mata$^2$, James Brookeman$^3$, Klaus Hagspiel$^3$, John Mugler$^3$  
$^1$Advanced MRI Technologies, Sebastopol, California, USA; $^2$University of Virginia, Charlottesville, Virginia, USA

The $^{129}$Xe gas exchange processes in lung are described with a 1D model and matched to experimentally determined depolarization data in rabbits. The model allowed estimating the effective $^{129}$Xe diffusion constant in lung parenchyma, the xenon membrane penetration depth as a function of time, the average lung tissue fraction involved in the gas exchange as well as the average alveolar diameter. Since the associated experimental studies were performed in healthy animals, our analysis provides baseline values that will serve as a reference for the detection of pathological changes in disease models.

**13:33 1687. $^{129}$Xe Lung Imaging with a Single-Shot Circular RARE Sequence**  
Kai Ruppert$^1$, Jaime Mata$^2$, James Brookeman$^3$, Jennifer Benjamin-Watkins$^2$, Talissa Altes$^2$, William Tobias$^2$, James Wang$^2$, Gordon Cates$^2$, John Mugler$^2$  
$^1$Advanced MRI Technologies, Sebastopol, California, USA; $^2$University of Virginia, Charlottesville, Virginia, USA

$^{129}$Xe lung images are presented that were acquired with a single-shot circular RARE pulse sequence to capture regional gas exchange properties of the lung in the form of a T2 contrast. At 1.5T the frequency difference of about 3,500 Hz between the gas phase and the lung tissue results in dephasing of any transverse magnetization that diffuses into the tissue and subsequently returns to the airspaces. Through this mechanism, the gas-phase signal decays rapidly in lung regions with substantial gas exchange. We demonstrated how this characteristic could be exploited to detect regions of tissue destruction in emphysematous lung.

**13:34 1688. Improving Optical Pumping Efficiency in the Production of Hyperpolarized Noble Gases for MRI Applications**  
Cavin L. Talbot$^1$, Marlies E J Friese$^1$, Deming Wang$^1$, David M. Doddrell$^1$, Ian M. Brereton$^1$, Norman R. Heckenberg$^1$, Halina Rubinsztein-Dunlop$^1$  
$^1$The University of Queensland, St Lucia, Queensland, Australia

Interest in the use of hyperpolarized (HP) noble gases $^3$He and $^{129}$Xe in magnetic resonance imaging (MRI) and spectroscopy (MRS) has significantly increased in recent years. Production of the gases is a key requirement for hyperpolarized noble gas MRI and MRS. HP $^3$He and $^{129}$Xe can both be produced using the spin-exchange optical pumping method. Here we describe our research directed toward efficient, cheap production of both HP $^3$He and $^{129}$Xe by optically optimizing the pumping process. We present our results on frequency narrowing of a 40W LDA, yielding a five-fold increase in optical pumping efficiency.

**13:35 1689. Remote Calibration of Accurate Hyperpolarized Gas Polarimetry to Thermally Polarized Water**  
Ian Andrew Nelson$^1$, Bastiaan Driehuys$^1$, Stephen Kadlecek$^1$  
$^1$Polarean, Durham, North Carolina, USA

We have built a free-standing device which performs calibrated measurements of the polarization of hyperpolarized gas samples. Several features of the device combine to make it accurate to better than 3%, repeatable to better than 1%, and largely independent of ambient field gradients. In addition, we have developed an active device which allows us to easily calibrate polarization measurement devices remotely while maintaining traceability to a thermally polarized water standard.

**13:36 1690. Development of a Very Low Field System for Hyperpolarized Noble Gas MRI**  
Jianbing James Chen$^1$, Arvind K. Venkatesh$^2$, Joey K. Mansour$^2$, Niral M. Shah$^2$, Mitchell S. Albert$^2$  
$^1$Massachusetts Institute of Technology, Boston, Massachusetts, USA; $^2$Brigham and Women’s Hospital and Harvard Medical School, Boston, Massachusetts, USA

The design of a low field imaging system is significantly different from conventional MRI systems since a variety of system issues, such as noise sources, the earth field's effect and signal amplification, need to be re-assessed. We present a redesigned VLF HP gas MR system with a wire-wound solenoid 15 mT magnet. The magnet is situated inside a RF enclosure. Circular waveguide filters, a filtered connector panel and custom-made gradient filters were installed for the noise reduction. Our preliminary results demonstrate the successful operation of the new VLF HP gas MRI system.

**13:37 1691. Liquid Hyperpolarized Xenon Production by Phase Exchange**  
Steven W. Morgan$^1$, Tining Su$^1$, Gary L. Samuelson$^1$, Gernot Laicher$^1$, Brian Saam$^1$  
$^1$University of Utah, Salt Lake City, Utah, USA

A new method is presented for producing hyperpolarized liquid $^{129}$Xe using spin-exchange optical pumping and subsequent phase exchange with a column of liquid. Xenon gas, polarized at the hot end of a cell, is carried by convection to the cold end, where it phase-exchanges with the liquid. This technique, which has produced 180 µL of 8% polarized liquid in ~15 minutes, has the potential to produce large quantities of hyperpolarized xenon without going through the solid phase, and to be a novel platform for polarization transfer experiments.
13:38  **1692. Highly Polarized Xe-129 and Resulting Improvements in MR Image Quality**

Gordon D. Cates¹, James R. Brookeman¹, Klaus D. Hagspiel¹, Jaime F. Mata¹, John P. Mugler III¹, Andrew G. Reish¹, W. Alexander Tobias¹, Hsuan-Tsong J. Wang¹

¹University of Virginia, Charlottesville, Virginia, USA

We present a study of MR imaging using hyperpolarized Xe-129 in which we examine the effect of using highly polarized gas. We also describe the methods we have used to achieve high polarization. We present two images that were made using 3% and 11% Xe-129 polarizations respectively. Despite a smaller-sized voxel on the high-polarization image, a dramatic improvement in image quality is achieved. The modifications to our gas-polarization apparatus included higher laser power, sol-gel coated polarization chambers, a larger volume magnet for the accumulation of xenon snow, and faster sublimation.

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**23Na Imaging: Techniques and Applications**

Room C-1  Wednesday 13:30 - 15:30

13:30  **1693. 23Na Microscopy of the Mouse Heart In Vivo**

Thomas Neuberger¹, Andreas Greiser¹, Axel Haase¹, Peter M. Jakob¹, Cornelius Faber¹, Andrew G. Webb¹

¹University of Wuerzburg, Wuerzburg, Germany

Localization of myocardial infarcted areas can be performed by observing the changes of the sodium signal. Since the mouse has become the most important animal model for human cardiac disease sodium imaging of the mouse heart is of outstanding interest. In this work we present sodium images of the mouse heart with a resolution as good as 1µl with a good signal to noise ratio. The ventricles, the septum and most of the myocardium are distinguishable. These results were possible through the combination of 3D Density Weighted Chemical Shift Imaging and a optimized instrumentation at high magnetic field strength.

13:31  **1694. Measurement of the Intra- versus Extracellular T₁ and T₂* Relaxation Times and Sodium Content in Healthy Rat Myocardium**

Reza Kharratzian¹, Hanns Hillenbrand¹, Elsbeth Fekete¹, Kai Hu¹, Peter Jakob¹, Axel Haase¹

¹University of Wuerzburg, Wuerzburg, Germany

We present a method to measure the localized intra- versus extracellular T₁ and T₂* relaxation times and sodium content in the isolated, perfused rat heart. The method is based on shift reagent (Tm[HDOTP]4-) - aided chemical shift imaging with variation of the excitation angle. Values (n=3, mean ± SD) for the intra- and extracellular T₁ were 39,9±12,4ms and 46,5±4,0ms, respectively. Correspondingly, the T₁* values were T₁*,intra=0.74±0.2ms (fast decaying component), T₁*,extra=8.2±1.3ms. Based on relaxation time data, a total sodium content was calculated.

13:32  **1695. Sodium MRI of Reversible Focal Brain Ischemia in the Monkey**

G. C. LaVerde¹, F. E. Bouda¹, D. Davis², E. Nemoto², C. A. Jungreis²

¹University of Pittsburgh, Pittsburgh, Pennsylvania, USA; ²University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

Sodium MRI has been proposed as a means to help extend the use of tPA to acute stroke patients that do not meet the accepted eligibility criteria. This study demonstrates the use of sodium MRI in a reversible, non-human primate model of focal ischemia. Our results found that the TSC rise is spatially heterogeneous with a spatial distribution that changes upon tissue reperfusion and that cannot be explained through partial voluming effects. This heterogeneity could have important implications during the clinical management of stroke.

13:33  **1696. CSF Suppressed Sodium Imaging of the Brain at 4.7 Tesla**

Robert W. Stobbe¹, Christian Beadieu¹

¹University of Alberta, Edmonton, Alberta, Canada

Cerebrospinal fluid (CSF) has a sodium concentration that is three times greater than brain tissue and hence dominates the sodium image of the brain. Small changes in brain tissue sodium, due to malignancy or ischemia, may be masked by brighter CSF signal. Tissue sodium in the human brain was imaged at 4.7 Tesla using an inversion-recovery (IR) 3D gradient-echo sequence to suppress the sodium signal contribution from CSF. The 3D IR-GRE technique was verified to significantly reduce saline/CSF sodium signal in a two compartment phantom (saline/agar) and in a healthy human volunteer.

13:34  **1697. Conventional and Radial K-space Sampling for 23Na MRI at 1.5T and 4T**

Sonia Nielles-Vallespin¹, Michael Boek¹, Achim Bankamp¹, Thorsten Thiel¹, Andre Bongers¹, Reiner Umathum¹, Lothar R. Schad²

¹German Cancer Research Centre, Heidelberg, Germany; ²Bruker BioSpin MRI, Ettlingen, Germany

In order to evaluate ²³Na MRI at 1.5T and 4T, a conventional 3D FLASH and a 3D radial pulse sequence were used in phantom and volunteer experiments of the head comparing SNR and spatial resolution. An increase in SNR between 1.5T and 4T of 2.7 in phantom experiments and of 4.0 in volunteer experiments was measured. The radial technique showed a better SNR than the FLASH, due to its shorter echo time (TE=400ls). It was shown that ²³Na MRI benefits from higher B0, achieving images of high SNR at acceptable measurement times.
13:35  **1698. A Comparison of Three SPRITE-Based Techniques for the Quantitative 3D Imaging of the $^{23}$Na Spin Density on a 4T Whole-Body Machine**  
*Sandro Romanzetti,1, Meghan Halse,2, Joachim Kaffanke,1, James Rioux,2, Bruce J. Balcom,2, N. Jon Shah,1*  
1Research Centre Juelich, Juelich, Germany; 2Univeristy of New Brunswick MRI Centre, Fredericton, New Brunswick, Canada

Sodium density maps acquired with three SPRITE-based methods have been compared in terms of the resulting quantitative information as well as acquisition times. Consideration of factors relevant for the clinical implementation of SPRITE shows that the Conical-SPRITE variant is preferred because of a 20-fold reduction in acquisition time, slightly improved image quality, and no loss of quantitative information. The acquisition of a 3D data set (32x32x16; FOV = 240mm isotropic) for the quantitative determination of sodium density in as little as 102s is demonstrated.

**New Contrast Agents: Theory, Development, and Applications**

**Room C-1  Thursday 13:30 - 15:30**

13:30  **1699. Localization of A Novel Contrast Agent Gadofluorine on Atherosclerotic Plaque of Apolipoprotein E Knockout Mouse Using In Vivo Magnetic Resonance Microscopy**  
*Juan Gilberto Aguinaldo,1, Venkatesh Mani,1, Marc Sirol,1, Vitalii Itskovich,1, John Fallon,1, Bernd Misselwitz,1, Hanns-Joachim Weinmann,1, Jean-Francois Toussaint,1, Zahi Fayad1*  
1Mount Sinai School of Medicine, New York, New York, USA; 2Schering AG, Berlin, Germany; 3Hospital Europeen Georges Pompidou, Paris, France

The diagnosis of atherosclerosis using MR with novel contrast agents has gained importance in detecting early cardiovascular disease. Gadofluorines, a new class of contrast agents, based on a macrocyclic, lipophilic gadolinium complex, forms micelles in aqueous solution with a potential for plaque enhancement. The objective of the study was to investigate the localization of a novel contrast agent Gadofluorine on atherosclerotic plaque using in-vivo Apolipoprotein E knockout mice. Results show Gadofluorine to be localized in the extracellular regions of the plaque. This may aid in detecting plaque burden and improve early detection of atherosclerosis.

13:31  **1700. Visualizing Atherosclerotic Plaques with Micelles: Does Size Matter?**  
*Juan C. Frias,1, Juan Gilberto S. Aguinaldo,1, Silvio Aime,2, John T. Fallon,1, Zahi A. Fayad1*  
1Mount Sinai School of Medicine, New York, New York, USA; 2University of Turin, Turin, Italy

New paramagnetic contrast agents based on mixed micelles were evaluated for in vivo imaging of atherosclerotic plaque detection. The mixed micelles were fully characterized (e.g., R1, payload, diameter, etc.). We demonstrated that the mixed micelles MR contrast agents localize and substantially enhance in vivo atherosclerotic plaques. Both large and small size diameter micelles with different paramagnetic payload (Gd3+/particle) appear to be effective.

13:32  **1701. In-Vivo and In-Vitro Uptake of Gadolinium-Containing Immuno-Micelles in a Macrophage Cell Line: Detection of Atherosclerotic Plaque using MRI**  
*Michael Joseph Lipinski,1, Juan Carlos Frias,2, Juan Gilberto S. Aguinaldo,1, Venkatesh Mani,1, John T. Fallon,1, Edward A. Fisher,1, Zahi A. Fayad1*  
1Mount Sinai School of Medicine, New York, New York, USA; 2New York University, New York, New York, USA

We set out to determine if an in-vitro murine macrophage cell line can be imaged using gadolinium-containing contrast agents, including an anti-CD204 immunomicelle. We also tested the immunomicelle in-vivo to image the descending aorta of an atherosclerotic mouse. The cells were incubated for 2 hours and revealed uptake of the contrast agents. The cells incubated with gadolinium-containing micelles had decreased T1 compared to Gd DTPA and the immunomicelle had the lowest T1. The immunomicelle also enhances atherosclerotic plaque 1 hour after injection. Gadolinium-containing immunomicelles may enable improved MR imaging of atherosclerotic plaque.

*John W. Chen,1, Ralph Weissleder,1, Alexei Bogdanov, Jr.1*  
1Massachusetts General Hospital, Charlestown, Massachusetts, USA

In high risk plaques, activated macrophages produce myeloperoxidase (MPO) in response to injury. We hypothesized that paramagnetic compounds that rapidly oxidize and polymerize in the presence of MPO may be used to detect the presence of MPO in tissues by MRI. We report here a MPO-responsive probe that demonstrates a 2-fold increase in relaxivity in the presence of MPO in aqueous solutions. Moreover, in a tissue model system a MPO-specific change in the MR signal was observed at the interface between Matrigel(tm) and substrate solutions. Therefore, we have made and validated the first MPO sensitive MR imaging agent.
Assessment of Angiogenesis: Dynamic Contrast-Enhanced MRI with Non-Targeted Ultraparamagnetic Nanoparticles Compared to Gd-DTPA in a Rabbit vx2 Tumor Model

Andrea Kassner1, Shelton D. Caruthers2, John S. Allen1, Todd A. Williams3, Patrick M. Winter1, Zhaohui Zhang1, Timothy P. Roberts1, Gregory M. Lanza2

1University of Toronto & UHN, Toronto, Ontario, Canada; 2Washington University School of Medicine, St Louis, Missouri, USA; 31st Affiliated Hospital to Sun-Yan Sen University, Guangzhou, People's Republic of China

Ultraparamagnetic nanoparticles (UPNs) are highly selective ligand contrast agents (CA), which can be used to image specific molecular pathways in vivo. However, when lacking the targeting moieties and injected in much higher quantities, UPNs act as a blood pool (BP) agent. We evaluated the BP effects and potential leakage of UPNs and compared this to that of Gd-DTPA. Analysis was performed using a 2 compartment model and results suggest that the relative area of CA leakage is greatly reduced compared to that of Gd-DTPA. Furthermore, areas that are consistent with CA leakage coincide with those where angiogenesis might be expected.

Specific MR Labeling of Angiogenesis-Associated Receptors Expressed by Endothelial Cells with Maghemite-antibody Conjugates

Jennifer Wolter1, Rolf Mentlein1, Ulrich Reus1, Carsten Liess1, Martin Heller2, Claus-C. Güler1

1University Hospital Kiel, Kiel, Germany; 2University of Kiel, Kiel, Germany; 3GKSS-Research Centre, Geesthacht, Germany

To study their potential as markers for angiogenesis the relaxation behavior of superparamagnetic maghemite nanoparticles was studied in saline buffer and in cells. Both unspecific and specific uptake in endothelial cells was quantitatively assessed as a function of incubation-concentration and -time and compared with TXRF. Specific uptake was achieved by coupling the nanoparticles to antibodies against VEGF-receptors known to be overexpressed during angiogenesis. The highest iron uptake was observed for the maghemite particle attached to VEGFR-1 antibodies at 20 μgFe/ml incubation-concentration and 45min incubation-time. Iron load calculated from T2 values was found to agree well with iron measurements based on TXRF.

Tracking of Endothelial Cell Response to Angiogenic Factors Using an Intracellular T2 Contrast Agent

Barjor Gimi1, Noriko Mori1, Ellen Ackerstaff1, Emma E. Frost1, Jeff W M Bulte1, Zaver M. Bhujwalla1

1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

An invasion MR assay was designed to non-destructively and longitudinally observe Human Umbilical Vein Endothelial Cells (HUVECs) invasion and network structure in ECM gel in the presence of the human breast cancer cell line MDA-MB-231. HUVECs were labeled with the paramagnetic contrast agent Feridex to identify them in T2-weighted MR images. HUVECs invaded ECM gel in chambers in the direction of MDA-MB-231 cancer cells. This invasion was not detected in the absence of cancer cells. The assay is designed to dynamically observe HUVEC response in a 3D milieu to various stimuli including angiogenic factors and antiangiogenic drugs.

Targeting of Integrins with a New Nonpeptidic RGD Mimetic Grafted to USPIO

Carmen Burtea1, Sophie Laurent1, Luce Vander Elst1, Robert N. Muller1

1University of Mons-Hainaut, Mons, Hainaut, Belgium

The integrin targeting with RGD (Arg-Gly-Asp) containing molecules has extensively been explored for therapeutic or diagnostic purposes. A new contrast agent has been synthesized by grafting a nonpeptide RGD mimetic on USPIO (USPIO-g-mimRGD). Its efficacy to target integrins has been tested on Jurkat cells. The results were compared with homologous contrast agents, i.e. GRGD peptide or CS1 fragment of Fibronectin grafted on USPIO. The results prove that USPIO-g-mimRGD is an efficient integrin-targeted contrast agent. The new compound is the first non-peptide RGD mimetic grafted to USPIO for diagnostic purposes, which can find a wide range of applications for the MRI.

Ferritin as Novel MR-Reporter for Molecular Imaging of Gene Expression

Baty Cohen1, Hagit Dafni1, Gila Metz1, Michal Neeman1

1The Weizmann Institute of Science, Rehovot, Israel

The H-chain of the murine ferritin, an iron storage molecule was used here as an endogenous reporter of gene expression by MRI. For assessment of feasibility, expression of EGFP and HA tagged H-ferritin were placed under tetracycline switch allowing multimodality detection of changes in expression using optical imaging, histology and MRI. The changes observed are consistent with redistribution of cellular iron and the anomality of relaxivity of ferritin in cells. Both unspecific and specific uptake in endothelial cells was quantitatively assessed as a function of incubation-concentration and -time and compared with TXRF. The results substantiates the plausibility of targeting underglycosylated MUC-1 in order to specifically recognize cells derived from MUC-1 expressing tumors.

Synthesis and In Vitro Characterization of a Combined MR/NIRF Imaging Probe for Cancer Detection

Zdravka O. Medarova1, Anna V. Moore1

1Massachusetts General Hospital, Harvard Medical School, Charlestown, Massachusetts, USA

This study describes the synthesis and in vitro characterization of a multimodal MR/NIRF imaging probe, CLIO-EPPT, which exploits cancer-associated upregulation and underglycosylation of the epithelial mucin antigen, MUC-1. The specificity of CLIO-EPPT for tumor cells was evaluated by a quantitative cell binding assay, flow cytometry, and fluorescence microscopy. MUC-1 negative cancer cell lines as well as noncancerous cell lines were used as controls. CLIO-EPPT was shown to specifically accumulate in MUC-1 expressing tumor cells. This investigation substantiates the plausibility of targeting underglycosylated MUC-1 in order to specifically recognize cells derived from MUC-1 expressing tumors.
**13:40 1709. A Liposomal System for Contrast-Enhanced MR Imaging of Molecular Targets**

Willem JM Mulder1, Gustav J. Strijkers2, Arjan W. Griffioen3, Gerben A. Koning3, Louis van Bloois4, Gert Storm5, Klaas Nicolay1

1Eindhoven University of Technology, Eindhoven, Netherlands; 2Maastricht University & University Hospital, Maastricht, Netherlands; 3Utrecht University, Utrecht, Netherlands

We have developed a MRI targeted contrast agent based on fluorescently labeled paramagnetic liposomes. The liposomes are coated with PEG to provide long circulation in vivo and a targeting ligand is coupled to the distal end of the PEG-chains to introduce specificity. We tested the liposomes in vitro on HUVECs that were treated with TNFa to upregulate the expression of E-selectin and were able to detect the expression of this molecular marker with MRI and fluorescence microscopy. The results demonstrate that this MR contrast agent may potentially serve as a useful diagnostic tool to investigate disease processes in vivo.

**13:41 1710. Design, Characterization, and Use of Magnetophages, a New Kind of MRI Contrast Agent**

Jérôme Segers1, Catherine Laumonier1, Sophie Laurent1, Luce Vander Elst1, Robert Muller2

1University of Mons-Hainaut, Mons, Hainaut, Belgium

Implementation of phage display technology to develop new MRI contrast agents led us to produce, characterize and test magnetophages, obtained by linking USPIOs to the phage wall. As shown by binding and competition assays, magnetophages behave as corresponding phages with respect to their affinity for the target. Due to their high field relaxivity r2 magnetophages appears as potential contrast agents for in vitro and in vivo MRI.

**13:42 1711. Preparation of MRI Contrast Agents Through Dispersion of Nanoparticles Produced by Laser Pyrolysis**

Jesus Ruiz-Cabello1, Rigoberto Pérez de Alejo1, José Pérez-Sánchez1, Sabino Veintemillas2

1Universidad Complutense, Madrid, Spain; 2Consejo Superior de Investigaciones Científicas, Madrid, Spain

Laser pyrolysis, a useful technique to tailor the preparation of a wide variety of nanosized magnetic powders with narrow size distributions, controlled physical properties and different chemical compositions, can be employed for the preparation of superparamagnetic contrast agents for MRI. Here the preparation of stable colloidal suspensions of very uniform laser produced iron oxide nanoparticles by dispersion and simultaneous coating of the powders with dextran in strong alkaline medium is performed. The relevance of this contribution comes from the fact that the route employed here for the preparation can be employed with magnetic metals and alloy nanoparticles.

**13:43 1712. S-GalTM, a Novel Proton MRI Reporter for β-galactosidase**

Weina Cui1, Zhenyi Ma1, Ralph P. Mason1

1UT Southwestern Medical Center at Dallas, Dallas, Texas, USA

S-GalTM is a recent detective toolkit of LacZ reporter gene. Upon cleavage by β-galactosidase in the presence of ferric ions (Fe3+), it can produce an intense visible black stain. We present data to show that the black complex is paramagnetic and distinguishable by MR whatever it forms because the existence of β-galactosidase or LacZ-expressed E.Coli. As a LacZ gene reporter molecule, S-gal TM provides us dual detectable methods: the visible black stain, and the contrast in proton MRI. So, we believe that following the metabolism of S-gal in vivo allows tracing gene therapy trials non-destructively in vivo.

**13:44 1713. Targeted MRI Contrast Agent Using Bioengineered scFv Fragments with Gadolinium Labelled Metal Binding Domain**

J K. Glazer1, M Malecki1, T M. Grist1

1University of Wisconsin, Madison, Wisconsin, USA

We pioneered a technology of recombinant chimeric proteins consisting of antitransferrin scFv antibodies as targeting domains, complexed to Gadolinium as reporter domains. We demonstrated that this complex is capable of preferentially labelling glioma cells, which are known to have a high concentration of transferrin, to a greater extent than a fibroblast control, and can produce a clinically relevant change in relaxivity by MRI at 1.5 Tesla.

**13:45 1714. Tracing Neuronal Pathways by MRI using WGA Coated Iron Oxide Nanoparticles**

Sebastien Boutry1, Sophie Laurent1, Luce Vander Elst1, Robert N. Muller1

1University of Mons-Hainaut, Mons, Hainaut, Belgium

To attempt to trace neuronal pathways in the brain by MRI, ultra small particles of iron oxide (USPIO) were coupled to wheat germ agglutinin (WGA), a lectin which is internalized by neurons and transported along axons after interaction with axon terminals. In vitro MRI experiments on neuron primary cultures showed that USPIO-g-WGA were inducing a stronger loss of cells signal intensity than parent USPIO, attesting of their affinity for neuronal cells. First in vivo experiment seemed to show a migration to cortex of striatum injected USPIO-g-WGA in mouse.
13:46 1715.  Paramagnetic Substance Isolated from Parazoanthus Axinelle as a New Specific Contrast Agent

Jerneja Strupl Suput1, Igor Sersa2, Dusan Suput1
1School of Medicine, Ljubljana, Slovenia; 2IJS, Ljubljana, Slovenia

Pseudozoanthoxantins are fluorescent water soluble molecules isolated from Parazoanthus axinellae. One of those substances, Pax, has been shown to bind to acetylcholinesterase (AChE). Here we report that the substance is not toxic when used at 10 nM or lower concentration, and that it is paramagnetic. It decreases T2 relaxation time and may be used as a specific contrast agent for showing AChE rich regions of brain.

13:47 1716.  Development of MRI Contrast Material for In Vivo Mapping of Transglutaminase Activity

Galit Mazooz1, Charles S. Greenberg2, Mark W. Dewhirst2, Michal Neeman1
1The Weizmann Institute of Science, Rehovot, Israel; 2Duke University Medical Center, Durham, North Carolina, USA

Transglutaminases are a family of enzymes involved in covalent cross-linking of the ECM. The cross-linking activity serves disparate biological processes depending on the location of the target protein. Extracellular activation of tissue transglutaminase (tTG) contributes to stabilization of the ECM and promotes cell-substrate interaction. Detection of tTG in cells and in ECM in the viable rim of MCF7 spheroids correlated with the sites of cross-linking activity. Biotin-TGS-GdDTPA (transglutaminase substrate) showed strong signal enhancement and high R1 relaxivity. This contrast material could potentially delineate in-vivo activity of transglutaminases in coagulation, as well as in angiogenesis and tumor progression.


Alexander Sukstanskii1, Dmitriy Yablonskiy1
1Washington University, St. Louis, Missouri, USA

A theoretical analysis of the MR signal formation in the presence of mesoscopic inhomogeneous magnetic field induced by MR superparamagnetic contrast agent is presented for the regime when water diffusion is important. The contrast agent (e.g., MION) is considered as a set of spherical magnetized inclusions. The theory is based on a Gaussian approximation for the distribution of phases accumulated by diffusing spins. General expressions for FID and SE signals are obtained and analyzed. Computer Monte-Carlo simulations of the signal are performed and a validity criterion of the Gaussian approximation is proposed.


Michael Alexander McDonald1, Kenneth L. Watkin1
1University of Illinois at Urbana-Champaign, Urbana, Illinois, USA

Advances in instrumentation and data acquisition are driving biomedical MR toward the use of higher magnetic fields, where standard clinical MRI gadolinium (III) contrast agents exhibit poor water relaxivity. To date, relatively few studies of the structure/activity relationship of crystalline, nanometer-sized T1 particulates have been carried out. The observation that dextran SPGO r1 is maintained even at very high fields indicates its potential utility as a high field T1 contrast agent. This behavior may be explained by solubilization of SPGO and may also be the result of an ideal lattice structure of the central gadolinium oxide crystal.

13:50 1719.  Methods of Quantifying Susceptibilities in Gel Phantoms

Yu-Chung Norman Cheng1, Muhammad Sohail Dawood2, Qiang Liu2, Jing Jiang2, E. Mark Haacke3
1Case Western Reserve University, Cleveland, Ohio, USA; 2Wayne State University, Detroit, Michigan, USA; 3440 E. Ferry St. Unit 2, Detroit, Michigan, USA

We study an experiment when an air tube is in the middle of a gel phantom. The susceptibility difference between the gel and air creates a phase variation in the gel. We compare a new approach to measure susceptibility using both magnitude and phase images and compare the results with those from a more conventional phase approach in gel phantoms. The challenge is to measure accurately the averaged susceptibility of a phantom. Our new method shows this advantage. The work will lead to the quantification of iron susceptibility in future.

13:51 1720.  Paramagnetic CEST Agents: Theory versus Experiment

Shanrong Zhang1, Donald E. Woessner2, Matthew E. Merritt1, A. Dean Sherry2
1University of Texas Southwestern Medical Center, Dallas, Texas, USA; 2University of Texas at Dallas, Richardson, Texas, USA

Theoretical simulations of experimental Z-spectra for a series of LnDOTAM3+ (where Ln3+ is a trivalent lanthanide cation and DOTAM is 1,4,7,10-tetraazacyclododecane-1,4,7,10-methylamide) complexes were carried out by using the modified Bloch equations for a three-pool (Ln3+-bound water, amide protons and bulk water) exchange model. Such simulations provide valuable insights into the influence of chemical shifts, water exchange rates, relaxation rates, applied B1 fields and saturation duration times on the observed CEST effect. This has proven valuable in the design of paramagnetic CEST agents with optimal efficiencies.
Biodegradable, PEGylated macromolecular Gd(III)DTPA-L-cystine copolymers were prepared and tested as a blood pool contrast agent on mice. The macromolecular contrast agent demonstrated superior contrast enhancement in the heart and blood vessels as compared to the low molecular weight control agent. At fifteen minutes, the PEGylated macromolecular agent still showed prominent enhancement. Little contrast enhancement by the control agent was detectable in the vasculature.

Animal experiments have shown that intracellular manganese (Mn) ions (Mn2+) may be promising contrast agents for imaging (MnMRI) of normal and ischemic myocardium (1-4). Cardiomyocytes accumulate paramagnetic Mn2+ by entry via slow calcium (Ca2+) channels (1,3) and by transient trapping in mitochondria. Binding to intracellular proteins enhances relaxivity of Mn2+ strongly (4) and improves further signal intensity in T1 weighted images. The aim of the present study was to examine whether MnMRI may be applied for imaging of human myocardium.

**13:55 1722. Preliminary Experience with Intracellular Manganese Ions as Contrast Agents in the Human Myocardium.**

*Arne Skjold1, Torgil R Vangberg1, Anders Kristoffersen1, Olav Haraldseth1, Henrik W Larsson1, Per Jynge2*

1St. Olav Hospital, Trondheim, Norway; 2NTNU, Trondheim, Norway

Animal experiments have shown that intracellular manganese (Mn) ions (Mn2+) may be promising contrast agents for imaging (MnMRI) of normal and ischemic myocardium (1-4). Cardiomyocytes accumulate paramagnetic Mn2+ by entry via slow calcium (Ca2+) channels (1,3) and by transient trapping in mitochondria. Binding to intracellular proteins enhances relaxivity of Mn2+ strongly (4) and improves further signal intensity in T1 weighted images. The aim of the present study was to examine whether MnMRI may be applied for imaging of human myocardium.

**13:54 1723. Results of Four Multicenter, Phase III, Magnetic Resonance Angiography Trials with MS-325, a Blood Pool Contrast Agent, for Detection of Vascular Disease in the Aortoiliac, Renal, and Pedal Regions**

*Gregory Sorensen1*

1Massachusetts General Hospital, Boston, Massachusetts, USA

MS-325 is the first contrast agent to complete a Phase III program and be submitted to the FDA for an MRA indication. Results of rigorous analysis of four clinical studies in vascular territories with varies blood flow patterns demonstrate the potential for MS-325-enhanced MRA as a viable alternative to diagnostic X-ray angiography.

**13:55 1724. Enhancing Lesions of the Brain: Intra-Individual Quantitative and Qualitative Comparison of Contrast Enhancement after Gadobenate Dimeglumine (Gd-BOPTA) versus Established Gadolinium Comparators**

*Armando Tartaro1, Tommaso Tartaglione2, Klaus Peter Lodemann3, Marco Essig4, Michael Knopp3, Gianpaolo Pirovano6, Miles Kirchin7*

1University of Chieti, Chieti, Italy; 2Policlinico Gemelli, Rome, Italy; 3Bracco-Altanapharma, Konstanz, Germany; 4German Cancer Research Center, Heidelberg, Germany; 5Ohio State University Hospital, Columbus, Ohio, USA; 6Bracco Diagnostics Inc., Princeton, New Jersey, USA; 7Bracco Imaging Spa, Milan, Italy

Gd-BOPTA at 0.1 mmol/kg was compared intra-individually with equivalent doses of Gd-DTPA and Gd-DOTA for brain tumor enhancement. T1wSE images were acquired at 2,4,6,8,10, and 15 min post-contrast with a T1wSE-MT sequence at 12 min. Quantitative comparison by independent blinded readers revealed significantly greater % enhancement (%En; p<0.0001), lesion-to-brain ratio (L/B; p<0.003) and contrast-to-noise ratio (C/N; p<0.03) for Gd-BOPTA-enhanced images at all time-points from 2 min post-contrast. Qualitative assessment revealed significant preference for Gd-BOPTA for lesion border delineation (p<0.004, both readers), lesion internal morphology (p<0.008, both readers), global contrast enhancement (p<0.0001, both readers) and global diagnostic preference (p<0.0005, both readers).

**13:56 1725. A New Glycosylated Complex of Gadolinium, a Potential Contrast Agent for MR Angiography**

*Mitsuji Yamashita1, Sophie Laurent1, Carmen Burtea2, Luce Vander Elst3, Robert N. Muller2*

1Shizuoka University, Hamamatsu, Japan; 2University of Mons-Hainaut, Mons, Hainaut, Belgium

Dendrimer-based MRI contrast agents are designed primarily to enhance the blood pool and the sites of abnormal endothelial permeability. The new contrast agent Gd-D1 is a low-molecular weight compound. It has been characterized by relaxometry, while its pharmacokinetic parameters and biodistribution pattern were determined on rats. Our new compound presents advantages as a blood-pool contrast agent not only from the relaxometric point of view but also from the biological one (convenient T1/T2 = 85 min and significantly lower accumulation in liver and spleen as compared to other dendrimer compounds).
**A Novel Efficient MRI Contrast Agent Containing Two Paramagnetic Centra**
Kristof Kimpe\(^1\), Sophie Laurent\(^2\), Tatjana Vogt\(^1\), Carmen Burtea\(^2\), Virginie Henrotte\(^2\), Luce Vander Elst\(^2\), Koen Binnemans\(^1\), Robert Muller\(^2\)
\(^1\)Katholieke Universiteit Leuven, Leuven, Belgium; \(^2\)University of Mons-Hainaut, Mons, Hainaut, Belgium

The accumulation of Gd\(^3+\) metalloporphyrins in tumoral necrosis was related to an albumin-binding mechanism. So, a similar retention in necrotic tissue should be expected for any agent with a albumin binding capacity. We have prepared and characterized a novel contrast agent, Gd\(^2\)-KA which shows non-covalent affinity for albumin. NMRD data show a higher relaxivity than Gd-DTPA. The HSA interaction also results in longer elimination half-life. The agent did not show any necrosis avidity, despite the structural similarity with metalloporphyrins and its binding to HSA. Hence, this study may discard the proposed mechanism of albumin binding for the necrosis targetability.

**A Self-Assembling Heteropolymetallic Chelate, Potential Contrast Agent for MR Angiography**
Kristof Kimpe\(^1\), Sophie Laurent\(^2\), Tatjana Vogt\(^1\), Carmen Burtea\(^2\), Koen Binnemans\(^1\), Robert N. Muller\(^2\)
\(^1\)Katholieke Universiteit Leuven, Leuven, Belgium; \(^2\)University of Mons-Hainaut, Mons, Hainaut, Belgium

A Gd-DTPA moiety linked to an iron(II) binding 1,10-phenanthroline unit, resulting in a supramolecular heteropolymetallic species, \([\text{Gd-DTPA-phen}]_3\text{Fe}\), has been synthesized, characterized and evaluated in vivo on rats by MR angiography. The molecular relaxivity of the complex is much higher than Gd-DTPA. The images show a clear enhancement of the arterial system: SI reaches a maximum enhancement of 45% after 7 min post-contrast and remains around 25% till the end of the imaging period (90 min); the SI enhancement produced by Magnevist was less than 5% during the same period.

**Labeling of Cells with MRI Contrast Agents**

**Comparison of Magnetic Labeling Methods of Neural Cells for MR Cell Tracking**
Sosuke Miyoshi\(^1\), Jennifer A. Flexman\(^1\), Donna J. Cross\(^1\), Kenneth R. Maravilla\(^1\), Yongmin Kim\(^1\), Junko Onishi\(^1\), Yoshimi Anzai\(^1\), Satoshi Minoshima\(^1\)
\(^1\)University of Washington, Seattle, Washington, USA

MR imaging provides the opportunity to observe magnetically-labeled neural cells in vivo. LipofectAMINE 2000, a popular liposomal reagent, has been used to transfect cells with superparamagnetic iron oxide (SPIO) particles but has also been associated with toxicity. Alternatively, viral envelopes of the hemagglutinating virus of Japan (HVJ-Es) can encapsulate SPIO particles and transfer these particles to the cell. We compared both methods according to microscopic observations, cell differentiation, iron content and MR imaging. Cell transfection with SPIO-HVJ-Es represents a non-toxic and more efficient technique of magnetic labeling as compared to lipofection.

**Magnetically Labeled Human Breast Cancer Cell In Vivo MR Imaging to Assess Tumor Metastasis; Experimental Animal Pilot Study**
Ho-taek Song\(^1\), Yong-min Huh\(^1\), Hyun Cheol Chung\(^1\), Sun Young Rha\(^1\), Duk-young Han\(^1\), Hye-lim Kang\(^1\), Jin-suck Suh\(^1\)
\(^1\)Yonsei University, College of Medicine, Seoul, Republic of Korea; \(^2\)Korea Basic Science Institute, Seoul, Republic of Korea

The purpose of this study is to evaluate whether implanted intracellular SPIO-labeled tumor cells in mouse can be used as a model for cancer metastasis. In vitro cellular MR imaging of the single tumor cells showed dark signal voids in a capillary tube. In vivo molecular MR imaging revealed that susceptibility-related signal drop could be traced in the region where SPIO labeled tumor cells has been implanted and growing until at least 25 days after the implantation. MR imaging for implantation model of magnetic labeled tumor cells could provide new insight for understanding tumor growth and spread such as metastasis.

**Cell Labeling using Superparamagnetic Iron Oxide Particles: Impact of Particle Size, Surface-Coating and Lipofection on Labeling Efficiency**
Lars Matuszewski\(^1\), Alexander Wall\(^1\), Thorsten Persigehl\(^1\), Wolfram Schwindt\(^1\), Bernd Tombach\(^1\), Manfred Fobker\(^1\), Christopher Poremba\(^1\), Walter Heindel\(^1\), Christoph Bremer\(^1\)
\(^1\)University Hospital Muenster, Muenster, NRW, Germany; \(^2\)Heinrich Heine University Duesseldorf, Duesseldorf, NRW, Germany

The aim of this study was to analyze the impact of lipofection, hydro-dynamic-diameter and surface-coating of different clinically approved superparamagnetic iron-oxide-particles (SPIOs) on the labeling efficiency in the presence or absence of a polycationic-transfection medium. All experiments demonstrated cellular iron-uptake verified by light-microscopy. Presence of TMs significantly increased the iron load of cells. As little as 10,000 cells were readily detectable with clinically available MR-techniques. Lipofection based cell-tagging is a simple method for efficient cell-labeling with clinically approved SPIOs. While large particle size is preferable for cell-tagging, surface coating might be less important in lipofection based cell-tagging methods.
13:33  **1731. Macrophage Infiltration into Grafts Detected Non-Invasively by MRI: An Early Marker of Allograft Chronic Rejection in a Rat Model of Kidney Transplantation**

Nicolau Beckmann1, Catherine Cannet1, Stefan Zurbruegg1, Reto Haberthuer1, Nadine Stohler1, Charles Pally1, Christian Bruns1

1Novartis Institutes for BioMedical Research, Basel, Switzerland

Macrophage infiltration into Fisher-to-Lewis rat kidney grafts was monitored using SPIO labeling. The cortical signal decreased significantly between 8 and 16 weeks after transplantation. The attenuation magnitude depended on the SPIO dose, administered i.v. 24 h before image acquisition. MRI signals correlated strongly to the Banff scores of rejection. Only a few occasional, weak correlations were encountered between Banff scores and blood or urine biochemical parameters. Infiltration of iron-labeled macrophages into grafts detected as signal attenuations by MRI thus provides a readout of early signs of chronic graft rejection, that is more reliable than blood/urine biochemical parameters.

13:34  **1732. An Improved Route for the Visualization of Stem Cells Labelled with a Gd-/Eu-Chelate as Dual (MRI and Fluorescent) Agent**

Simonetta Geninatti Crich1, Luigi Biancone1, Vincenzo Cantaluppi1, Debora Duò1, Giovanna Esposito1, Simona Russo1, Giovanni Camussi1, Silvio Aime1

1University of Torino, Torino, Italy

Pluripotent stem cells deserve a great therapeutic potential for their capacity of regenerating damaged tissues in the presence of a number of pathologies. The possibility of their in vivo visualization will allow to monitor the fate and localization of the transplanted cells. For these reasons we thought of interest to explore routes to label stem cells based on the use of a well tolerated, small-sized paramagnetic Gd (III) chelate. Moreover the close analogy between Gd3+ and Eu3+ ions suggests the development of a dual probe thanks to the fluorescent properties of the latter one.

13:35  **1733. Dual-Labeled Nanoparticles for Studying Cell Migration and Trafficking via Optical and Magnetic Resonance Imaging**

Kien Vuu1, Jianwu Xie2, Yantian Zhang2, Samira Guccione2, King Li2, Mark Bednarski2

1Howard Hughes Medical Institute-National Institutes of Health Research Scholars Program, Bethesda, Maryland, USA; 2National Institutes of Health, Bethesda, Maryland, USA

Many techniques for the study of cell transplantation require histological analysis to determine the fate of cells. These techniques lack the ability to serially track these cells in vivo. Magnetic labeling of cells does allow the in vivo tracking via MRI, however, these techniques lack the ability to characterize the transplanted cells at a cellular level. We report the construction of a dual-labeled gadolinium-rhodamine polymerized nanoparticle that achieves both these purposes. These fluorescent MR contrast agents can potentially be used for serial monitoring of cell trafficking in vivo, MRI-guided tissue procurement, and detailed cellular characterization via optical imaging.


Erik M. Shapiro1, Alan P. Koretsky1

1National Institutes of Health, Bethesda, Maryland, USA

Molecular and cellular MRI would be aided by in-vivo single cell detection. We investigated the capacity of cells to endocytose different size particles, 0.96, 1.63 and 2.79 microns, and measured their MRI signatures at three different field strengths, 4.7, 7.0 and 11.7 Tesla, with different imaging resolutions and TE’s. Cells readily endocytose >100 0.96 and 1.63 micron particles, and as high as 75 2.79 micron particles. Contrast regions up to 500 microns were observed for single cells in vitro. These measurements will aid in the design of in-vivo studies by determining imaging conditions necessary for single cell detection in various systems.

**Tracking of Labeled (Stem) Cells**

Room C-1  Tuesday 13:30 - 15:30

13:30  **1735. MRI Detection of Angiogenesis in Ischemic Brain Remodeling After Cell Therapy in Rats with Stroke**

Quan Jiang1, ZhengGang Zhang1, GuangLiang Ding1, James R. Ewing1, RuiLan Zhang1, Li Zhang1, Lian Li1, Polly Arniego1, JianNi Hu1, QingJiang Li1, Lei Wang1, He Meng1, Robert A. Knight1, Michael Chopp1

1Henry Ford Health System, Detroit, Michigan, USA; 2Wayne State University, Detroit, Michigan, USA

We intracereinally transplanted adult SVZ cells labeled by superparamagnetic particles into adult rats after stroke. We found that MRI detects angiogenesis after SVZ treatment, and transplanted cells selectively migrate to the ischemic parenchyma in living rats. Angiogenesis and migration and integration of transplanted cells in the host brain were also detected using histochemical staining. Our data suggest that intracerebral transplantation of adult SVZ cells may provide an avenue for cell therapy of stroke and that MRI can be used to detect migration of grafted cells and cell induced brain remodeling in the host brain in living animals.
Stem cell transplantation in Parkinson’s disease lacks an noninvasive method for the tracking of transplanted cells. To address this question by the use of MRI we are magnetically labelling murine embryonic stem cells with iron-oxide particles (VSOP) in vitro and transplant the cells in the striatum of a Parkinson rat model. Additionally we examined for the first time whether incubation with VSOP can increase the cellular level of oxidative stress. We were able to detect the location and migration of the labelled stem cells 4 months after transplantation by high-resolution MRI.

**13:32 1737. In Vivo Detection of Small Numbers of Magnetically Labeled Embryonic Stem Cells**

**Albrecht Stroh**, **Peer Lorenz**, **Tilman Grune**, **Herbert Pilgrim**

1Charité University Hospital, Berlin, Germany; 2Ferropharm, Teltow, Germany; 3University Hospital Leipzig, Leipzig, Germany

Labeling stem cells with very small superparamagnetic iron-oxide particles as contrast agent allows detection of very small cell numbers after transplantation in vivo. Here, we show that as few as 100 labeled cells can be easily identified in gel phantoms and in the rat brain in vivo using 3D FLASH sequence at 17.6 T. Signal attenuation observed after transplantation of 20 cells could not be assigned unambiguously to the cells.


**Ho-tae Kwon**, **Yong-min Huh**, **Seung-cheol Lee**, **Jee-hyun Cho**, **Kwan Soo Hong**, **Hye-lim Kang**

1Yonsei University, College of Medicine, Seoul, Republic of Korea; 2Korea Basic Science Institute, Daejeon, Republic of Korea

Detection of intravenously injected, implanted, transplanted, magnetically labeled stem cells is important for in vivo and in vitro or ex vivo MR trafficking and validation. Superparamagnetic iron oxide (SPIO) particles appear larger than their actual size, which benefits for sensitive detection of labeled cells. On the other hand, this might interfere accurate characterization of the target. Our 10 µm pixel high resolution cellular imaging revealed that blooming artifacts did not extend over the estimated cell boundary. Magnetically labeled stem cell imaging was possible at the cellular level and might provide new insights for individual stem cell trafficking.

**13:34 1739. The Use of MRI to Track the Migration of Labelled Neutrophils to Lung Inflammation in the Rat.**

**Sarah Hotte**, **Kumar Changani**, **Alan White**, **Kishore Bhakoo**, **Jimmy Bell**

1MRC Clinical Sciences Centre, London, UK; 2GlaxoSmithKline PLC, Welwyn Garden City, UK

Neutrophils are known to be involved in the pathogenesis of various lung inflammatory diseases (e.g. COPD and ARDS). Here we investigated the use of MRI to track labelled neutrophils to lung inflammation in the rat. Rat neutrophils were isolated and labelled with antibody attached MION. The migration of these labelled cells to areas of lung inflammation was monitored. Quantification of signal reduction due to the presence of MION labelled cells in inflamed regions proved significant. This suggests that MRI can be used to track the migration of neutrophils to the lung.

**13:35 1740. MRI Assessment of Magnetically-labeled Mesenchymal Stem Cells in a Canine Model of Reperfused Myocardial Infarction**

**Dara L. Kraitchman**, **Evelin Izbudak**, **Parag Karmarkar**, **Long Tai**, **Danielle Fritzges**

1Johns Hopkins University, School of Medicine, Baltimore, Maryland, USA; 2University of Pennsylvania, School of Veterinary Medicine, Kennett Square, Pennsylvania, USA; 3Osiris Therapeutics, Inc., Baltimore, Maryland, USA

MR-labeling of mesenchymal stem cells (MSCs) offers a method to enhance targeting of delivery and tracking cell fate over time. Using a reperfused canine myocardial infarction (MI) model, MR-labeled MSCs were delivered using MR fluoroscopic guidance. Global function measures and infarct size, determined at follow-up MRI were compared between MSC-treated dogs and non-treated controls. A reduction of infarct size over 2 months was seen in both groups. However, LV mass was preserved in MSC-treated dogs only. Concurrent with LV mass preservation, improvements in global function measurements were observed up to 4 weeks post-MI in MSC-treated dogs.

**13:36 1741. MR Tracking of I.V. Injected Magnetically Labeled Mesenchymal Stem Cells (MSCs) in a Rat Model of Nephropathy.**

**Olivier Hauger**, **Emma Frost**, **Raud van Heeswijk**, **Yahsou Delmas**, **Rong Xue**, **Chrit Moonen**

1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; 2ERT CNRS/Université Bordeaux 2, Bordeaux, France

Magnetically labeled mesenchymal stem cells were intravenously injected in rats with peristant glomerular damage and imaged both in-vivo (4.7T) and ex-vivo (9.4T) using gradient-echo sequences. In vivo imaging did not show signal drop whereas ex-vivo scanning showed focal areas of cortical signal decrease. Immunohistology confirmed the presence of labeled cells in focal damaged cortical kidney areas.
13:37  1742. MRI of Transplanted Pancreatic Islets
Daniel Jirak1, Jan Kriz1, Vit Herynek1, Benita Andersson2, Peter Girman1, Frantisek Saudek1, Milan Hajek1
1Institute for Clinical and Experimental Medicine, Prague, Czech Republic; 2Karolinska Institutet, Stockholm, Sweden

The purpose of this study was to monitor in vivo the distribution and function of magnetically labeled pancreatic islets transplanted into the liver in an animal model. Labeled pancreatic islets were clearly visible as hypointense spots regularly distributed in the liver on T2*W MR images and remained detectable for at least 20 weeks. The labeled islets were fully functional as assessed by normalization of blood glucose levels in diabetic animals.

13:38  1743. Intravascular Injection of Magnetically Labeled Mesenchymal Stem Cells in Kidney and Liver: In Vivo MR Imaging Results
Clemens Bos1, Yahsou Delmas2, Alexis Desmoulière1, Anne Solanilla1, Jean Rosenbaum1, Jean Ripoche1, Jeff W.M. Bulte3, Nicolas Grenier1, Christian Combe2, Chrit T.W. Moonen1
1Université ‘Victor Segalen’ Bordeaux-2, Bordeaux, France; 2INSERM U 441, Pessac, France; 3Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

In vivo MR-imaging of intravascularly injected mesenchymal stem cells was studied. Cells were magnetically labeled using Endorem/Superfect and injected in the renal artery or portal vein of rats. Serial T2*-weighted imaging and R2*-mapping was performed on a 1.5-T scanner in clinically feasible imaging times. In the kidney, a signal drop in renal cortex was observed, that persisted up to one week. In the liver, a diffuse granular appearance resulted, that stayed at least 12 days. Signal loss corresponded with iron-loaded cells in renal glomeruli and hepatic sinusoids, on histology. Immunohistochemistry confirmed these cells were mesenchymal stem cells.

13:39  1744. Monitoring Stem Cell Migration in the Normal Mouse Brain by MRI
Sergey Magnitsky1, Deborah J. Watson2, Raquel M. Walton3, Stephen Pickup1, Jeff W.M Bulte4, John H. Wolfe2, Harish Poptani1
1University of Pennsylvania, Philadelphia, Pennsylvania, USA; 2Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA; 3University of Pennsylvania School of Veterinary Medicine, Philadelphia, Pennsylvania, USA; 4Johns Hopkins University, Baltimore, Maryland, USA

Neural stem cells (NSC) can correct lysosomal storage diseases in the brain. C17.2 NSC cells were labeled and transplanted into adult or neonatal brains and monitored by MRI. In adult mouse brain NSC’s were detected up to 32 days after transplantation with some degree of relocation along the white matter tracts. In contrast, NSC’s implanted neonatally migrated throughout the brain. Prussian blue staining for iron correlated well with MRI images. In vivo detection of different migration patterns in adult and neonatal mouse brain may be due to differences in engraftment potential and may help in developing stem cell based therapies.

Molecular Imaging: Diagnosis and Therapy

Room C-1  Wednesday 13:30 - 15:30

13:30  1745. Simultaneous T2* Mapping and Anatomical Imaging using a Fast Radial Multi-Gradient-Echo Acquisition
Hannes Dahnke1, Steffen Weiss1, Tobias Schaeffter1
1Philips Research Laboratories, Hamburg, Germany

We present a new method for T2* relaxometry, which combines a novel scheme for rapid acquisition of the MRI data with a fast exponential fitting routine to account for the demands of real time applications. These applications can be found in the scope of molecular imaging and real time cell tracking, since T2* mapping leads to a more accurate determination of contrast agent distribution than T2* weighted imaging.

Ian John Rowland1, Helle Jul Simonsen1
1Danish Research Centre for Magnetic Resonance, Hvidovre, Denmark

High efficiency gene transfer into muscle can be achieved using electrotransfer techniques. However, the application of short, high voltage electric pulses invariably results in tissue damage. Rat muscle damage was investigated using MR at times ranging from 2 hours to 14 days after the application of electric pulses typical of those used successfully in electrotransfer gene delivery. This study investigates the resolution of muscle oedema and shows that MR is highly suited for monitoring muscle damage and repair and can, therefore, be used to optimize gene therapy protocols.
13:32  **1747. 1H Magnetic Resonance Spectroscopic Imaging of Phospholipase Activity in Rat Gliomas In Vivo**

Timo Liimatainen, Arja Erkkilä, Olli Gröhn, Helvi Vidgren, Piia Valonen, Seppo Ylä-Herttuala, Juhana M. Hakumäki

1University of Kuopio, Kuopio, Finland

We have studied HSV-thymidine kinase-positive BT4C gliomas in vivo with ultra-short echo time quantitative proton magnetic resonance spectroscopic imaging (MRSI) in combination with extensive biochemical analysis of main cell membrane constituents. The data establish a meaningful quantitative relationship between phospholipase-mediated membrane lipid catabolism and 1H NMR-visible lipid accumulation in vivo. We also demonstrate that even in these small experimental tumors undergoing ganciclovir-induced apoptosis, regional differences in membrane catabolism during treatment can be now accurately visualised and quantified in situ.

13:33  **1748. Engineering a Novel Receptor for Molecular Imaging**

Paul Winnard Jr., Yelena Mironchik, Flonne Wildes, Zaver Bhujwalla, Venu Raman

1The Johns Hopkins University, Baltimore, Maryland, USA

Molecular imaging strategies using non-invasive imaging techniques such as MRI, are currently being developed in mouse model systems where these strategies can be optimized. Imaging strategies based on endogenous receptors can suffer from a number of potential drawbacks. Our goal is to develop a non-mammalian receptor/ligand imaging system, to overcome such potential difficulties. We are evaluating fusion constructs of plasma membrane receptors. Our receptors have been engineered to have a native mammalian transmembrane type II receptor signal/anchor domain fused to the ligand binding-site of a non-mammalian type II receptor Er-1mem. The latter is from the marine protozoan ciliate Euplotes raikovi.

13:34  **1749. MRI - Imaging, Histological Analysis and Gene Expression of a Squamous Cell Carcinoma Model Treated with Focused Ultrasound**

Walter Hundt, Esther Yuh, Mark Bednarski

1Stanford University School of Medicine, Stanford, California, USA

C3H/Km mice were implanted with SCC cells in each flank. Focused ultrasound was applied to the tumors using a imaging/therapeutic ultrasound system. Two different modes were applied: a continuous or a pulsed mode. 4 hours after treatment MRI images were obtained, histology and gene analysis performed. Significant MRI changes were seen in the continuous mode but not in the pulsed mode. Gene expression analysis revealed profound changes in the expression levels of 4 genes in the continuous FUS-treated tumors and 2 complete different genes in the other mode. Functional genomic analyses revealed potential targets for developing of molecular imaging probes.

13:35  **1750. Local and Reversible Blood-Brain-Barrier Disruption by Noninvasive Focused Ultrasound at Frequencies Suitable for Trans-Skull Sonications**

Kullervo Hynynen, Nathan McDannold, Nickolai Sheikov, Natalia Vykhodtseva, Ferenc Jolesz

1Harvard Medical School & Brigham and Women's Hospital, Boston, Massachusetts, USA

Previously, we demonstrated that focused ultrasound in conjunction with an ultrasound contrast agent could induce temporary and localized blood-brain barrier (BBB) disruption, and that this procedure could be monitored with MRI. There, the ultrasound frequency was 1.63 MHz. It has been shown elsewhere that sonications can be performed through the intact skull at lower frequencies. In this work, we demonstrated that focused ultrasound could open the BBB at a frequency suitable for such transcranial sonications. In addition, using electron microscopy, we showed that a large molecule agent (horse radish peroxidase) passed through the BBB via both transendothelial and paraendothelial routes.

13:36  **1751. Identification of Serum Protein Profiles of Glioblastoma Multiforme Patients: Using Image-Guided Microarray Analysis of Tumor Samples to Identify Serum Markers**

Samira Guccione, Yi-Shan Yang, Yingyung Wang, Michael Lim, Ron Homer, Griff Harsh, Scott Atlas, Mark Bednarski

1Stanford University, Stanford, California, USA

In this study, contrast enhanced MRI was used to identify regions in human GBM associated with high vascularity and permeability. It improves the accuracy of tissue sampling for genomic profiling to identify targets for therapeutics. Targets discovered in the contrast-enhanced region in GBM may provide serum markers for disease monitoring.
Microscopy and Tissue/Materials Characterization

Room C-1    Thursday 13:30 - 15:30

13:30 1752. A Multiple Mouse Biological Loading and Monitoring System for MRI
Jun Dazai1, Nicholas A. Bock1, Lorinda Davidson1, Brian J. Nieman1, R. Mark Henkelman2, X. Josette Chen1
1Hospital for Sick Children, Toronto, Ontario, Canada

Mouse MRI studies have become significant in facilitating research on human disease models due to their genetic homology. Three-dimensional, high-resolution images of live mice have also allowed for further insight into anatomy and function. However, with imaging times on the order of hours, high throughput of specimens has been problematic. In this study, we demonstrate the ease and rapidity with which we can load and anesthetize seven mice for a multiple-mouse imaging session. With custom-built equipment we are able to monitor ECG and temperature and regulate anesthetic and heating. The total preparation time for 7 mice is approximately 24 minutes.

13:31 1753. Multiple Mouse MRI of 16 Mice
Jonathan Bishop1, Nicholas Bock2, Brian Nieman2, Jun Dazai1, Lori Davidson1, Mark Henkelman2
1Hospital for Sick Children, Toronto, Ontario, Canada; 2University of Toronto, Toronto, Ontario, Canada

Whole-body imaging of fixed mice has been conducted on 16 mice in parallel. The basic concept of multiple mouse MRI with a common gradient coil has been fully realized.

13:32 1754. Feasibility of In Vivo Microimaging of the Mouse in a Conventional 1.5 T Body Scanner Equipped with a 12 mm HTS Surface Coil
Marie Poirier-Quinot1, Jean-Christophe Ginefri1, Philippe Robert2, Luc Darrasse1
1U2R2M CNRS UMR8081, Orsay, France; 2Guerbet Research, Aulnay-Sous-Bois, France

MRI performance accessible in the mouse using a conventional 1.5T body scanner and a 12mm superconducting surface coil is investigated. High-quality micro-imaging was demonstrated in the head, the back, and a subcutaneous tumor model (MDA-MB-435), isotropic voxels of 60 µm being defined in less than one hour. SNR gain of 4.5x is obtained about the head as compared to a room-temperature copper coil mimic. High spatial-resolution (voxels of 0.11 mm) is also achieved at a 0.9 second time resolution which allows to analyze the perfusion phase in different areas of the tumor after injection of GD-DOTA (Dotarem®Guerbet-France).

13:33 1755. Diffusion Tensor MR Microscopy of Adult Zebrafish
Raisa Z. Freidlin1, H. Douglas Morris1, Ferenc Horkay1, Carlo Pierpaoli1, Reiko Toyama1, Igor B. Dawid3, Peter J. Basser1
1National Institutes of Health, Bethesda, Maryland, USA

We use Diffusion Tensor MR Microscopy (DT-MRM) techniques to study adult zebrafish in vitro. While the young zebrafish is optically transparent, and amenable to study by light microscopy, the adult is optically turbid so that conventional microscopy techniques fail. DT-MRM can be applied in this case to identify various tissue types, and possibly subtle anatomical or structural differences between them resulting from differences in gene expression between normals and knockouts.

13:34 1756. Diffusion Tensor Microscopy of Gastrula Stage Xenopus Laevis Embryos
J. Michael Tyszka1, Andrew J. Ewald2, Cyrus Papan3, Scott E. Fraser1, Russell E. Jacobs1
1Caltech, Pasadena, California, USA; 2UCSF, San Francisco, California, USA

The Xenopus Laevis (African Clawed Frog) embryo is a classical model of early vertebrate development and its opacity makes it particularly suitable for non-invasive study with MRI. We present here proof-of-concept results for PGSE DTI microscopy of fixed gastrula stage embryos. Although limited by short intrinsic T2 values and large restriction scales, PGSE DTI still provides useful contrast arising from diffusion restrictions which may allow tracking of developmental interactions.

13:35 1757. Progress in Continuous Harmonic Excitation MR Elastography of the Brain
Scott A. Kruse1, M. Alex Dresner1, Richard L. Ehman1
1Mayo Clinic & Foundation, Rochester, Minnesota, USA

Improvements were made to the three main Magnetic Resonance Elastography (MRE) components. This includes development of new shear wave application device, acquisition parameters and new techniques for analyzing data. The results were: improved volunteer comfort, increased shear wave illumination, faster scan times, and enhanced shear stiffness estimation.
Magnetic resonance elastography (MRE) is a method that can visualize the propagating acoustic strain waves in materials. The local quantitative values of shear modulus are calculated from distribution of the acoustic strain waves in the MRE image. In order to observe tissues such as the early stage of tumors in detail, spatial resolution of the MRE image is not enough because of hardware limitation of the conventional MRS system. Therefore we developed an elasticity measurement system using MR microscope. To confirm the availability of this system, phantom and in-vitro study were performed, and the elastic properties were quantitatively depicted.

In MR Elastography (MRE) the evaluation of local wavelengths allows to determine linear elastic material constants. However, many in vivo tissues show strong deviations from linear elastic behavior. Here, a technique is introduced based on MRE that allows to measure non-linear elastic properties by analyzing the frequency-content of shear vibrations. The method allows to spatially and temporally resolve propagating shear waves. Experiments were performed on Agarose exposed to 150Hz harmonic shear vibrations. Selective filtering of the 4th and 5th harmonics resulted in signals, which could be attributed to non-linear elastic properties using a numerical solution of Burger's equation.

A 3D method was designed to delineate automatically the trabecular region and the cortical one on in vivo 7 T MR images of the human finger (156 µm isotropic resolution and SNR of 10). The trabecular ROI was binarized using an algorithm for partial volume reduction dedicated to in vivo trabecular bone MR images. Architecture parameters were computed in order to establish reproducibility of the measurements between two images of the same healthy volunteer. This study enables monitoring of architecture parameters on defined ROIs, and thus potentially the follow-up of disease progression or of treatment efficiency.

The goal is to detect force signals in attonewton range or smaller. This force coupled resonantly to a harmonically bound oscillator can be used to measure the change of magnetization, which occurs when a paramagnetic sample is polarized in a inhomogeneous static magnetic field and perpendicular to this, a high frequency magnetic field irradiate at Larmor frequency. Typical field gradients are in the order of 1G/µm. Single crystalline silicon cantilevers can achieve sensitivities the order of 10-18-10-19 N/^Hz under UHV conditions. In a wide temperature range interesting phenomena such as phase transitions, transport and dissipation effects can be observed.

Only the contours of solid implant bodies based on resins or composites might be visualized by standard 2DFT MR-imaging leaving inner structure including possible manufacturing errors or mechanical degradation due to mechanical stress undetected. We investigated, whether it is possible to visualize resins and composites by special pure phase encoding MR-methods (Single Point Imaging: SPI) and detect also inhomogeneities in the material due to incomplete polymerization and mechanical stress. We also investigated which resolution might be obtained with 3 dimensional SPI using specifically designed phantoms based on resins.

T2-weighted high-resolution MRI mouse images generally exhibit superior endogenous contrast than their T1-weighted counterparts but require very long repetition times, limiting their use in live imaging applications. Modifications to a standard fast spin-echo sequence are implemented and compared in phantoms and fixed mice to assess feasibility of acquiring T2-contrast with short repetition times. A fast spin-echo with a reduced excitation tip angle is shown to obtain much improved contrast at reduced scan time without compromise in SNR, showing promise for use in high-resolution in vivo applications.
**MR Imaging of Cu2+ Treated Alzheimer Disease Tissue**
Chun-Wei Chen1, Anne Cataldo1, Wen-Fu Lai2, Perry Renshaw1, Chun Zuo1
1McLean Hospital, Belmont, Massachusetts, USA; 2Taipei Medical University, Taipei, Taiwan, Taiwan

Alzheimer’s disease is characterized by amyloid deposits within the neocortical parenchyma and the cerebrovasculature. Amyloid-beta is cleaved out of the amyloid protein precursor which possesses copper/zinc binding sites in its amino-terminal and in the Abeta (affinity Zn2+>Cu2+>Fe3+). Those binding-sites may be still available in amyloid deposits and may be utilized for MR imaging of AD tissue. We have tested the feasibility of using Cu2+ to assess amyloid deposits with imaging of Cu2+ treated AD tissue at 3T and histologic validation. Our data indicated higher Cu2+ uptake in AD gray matter probably via available sites on plaques, cerebrovasculature, and residual RBCs.

**Elastography**
Room C-1 Thursday 13:30 - 15:30

**Temporal Phase Unwrapping Aids 3-D MR Elastography of Prostate Specimens**
M. Alex Dresner1, Roger C. Grimm1, Armando Manduca1, Richard Ehman1
1Mayo Clinic, Rochester, Minnesota, USA

Phase wraps in MR Elastography (MRE) can require unique solutions when existing 2-D algorithms prove insufficient. Specific algorithms have been devised for 4-D MRE data (from a study of human prostate specimens) that capitalize on the time-harmonic nature of the data. Also, the amplitude and phase of the displacement data can be disassociated, allowing limitation of amplitudes (which appear artificially high where unwrapping algorithms fail) without affecting the shear wavelengths. These corrections improved the ability to distinguish prostate cancer on the basis of tissue stiffness in this study of 16 prostatectomy specimens.

**Accelerating MR Elastography: A Multi-Echo Phase Contrast Gradient Echo Sequence**
Stefan Maderwald1, Kai Uffmann1, Harald H. Quick1, Armin de Greiff1, Mark E. Ladd1
1University Hospital Essen, Essen, NRW, Germany

MR elastography (MRE) uses visualized shear waves induced into tissue to determine the tissue elasticity. A conventional single gradient echo phase contrast sequence was modified into a multi-echo phase contrast sequence with special motion-sensitizing gradients for measuring such shear waves. Elasticity measurements with different echo train lengths were performed in a phantom to prove the feasibility of this sequence type for MRE. Multi-echo phase contrast MRE significantly speeds up the acquisition time, however, at the cost of accuracy, SNR, and arising artifacts. First in vivo datasets are presented.

**A Fast Acquisition Method for 3D Displacement and Strain Imaging**
Derek D. Steele1, Thomas L. Chenevert1, Stanislav Y. Emelianov2
1University of Michigan, Ann Arbor, Michigan, USA; 2University of Texas, Austin, Texas, USA

We present displaced-echo meta-DENSE, a fast method for acquiring volumetric, displacement-encoded data. 128x128x16 images of the 3D displacement vector in a silicone gel phantom were acquired in 16 minutes using an echo train length of 16. This sixteen-fold decrease in acquisition time comes with an increase in the displacement estimation error when compared to a single-echo acquisition, from an average of 14 microns to 19 microns. Ultimately, this method provides a technique for clinically feasible, quasi-static 3D elasticity imaging.

**Determination of Gray and White Matter Elasticity with MR Elastography**
Kai Uffmann1, Stefan Maderwald1, Armin de Greiff1, Mark E. Ladd1
1University Hospital Essen, Essen, Germany

The feasibility of MR Elastography for measuring the elasticity of the brain has already been shown. But it is still not clarified whether gray matter elasticity in vivo is higher than that of white matter or vice versa. The feasibility of the method including reconstructed elastograms was examined. With the help of gray and white matter segments extracted from T2 weighted images, evaluation of elasticity values can be performed separately for the two tissue types. Evaluation of examinations performed in seven healthy volunteers yielded a higher elasticity of white matter in comparison to gray matter.

**High-Resolution MR Elastography of Human Skin**
Stefan Maderwald1, Harald H. Quick1, Kai Uffmann1, Roya Jeyrani1, Anja Liffers2, Mark E. Ladd1
1University Hospital Essen, Essen, NRW, Germany; 2Ruhr-University Bochum, Bochum, NRW, Germany

A surface receiver-coil was constructed to image shear waves propagating through the skin and subcutaneous fat. This enabled us to quantify the stiffness of the tissue with MR Elastography reconstruction algorithms. Nine volunteers without abnormalities in the region of interest were investigated. The signal of the surface receiver coil was sufficient to acquire phase images with different phase offsets with a modified phase contrast sequence. A spatial resolution of up to 0.1*x0.1*0.34 mm3 per voxel was achieved.
13:35  **1770. MR Elastography of Radiofrequency Ablation Lesions**

Kai Uffmann, Harald H. Quick, Florian Vogl, Mark E. Ladd

1University of Maryland Medical Center, Baltimore, Maryland, USA

Efficient interventional thermotherapy with radiofrequency (RF) ablation requires visual control of the resulting lesion size. Radiofrequency ablations cause lesions due to tissue denaturization. This changes the elasticity of the ablated tissue. MR Elastography (MRE) has shown the potential to measure differences in the elasticity value via shear waves propagating through tissue. The present study investigates the feasibility of in situ determination of RF lesion size with MRE in the liver of a mini pig including a lesion induced by radiofrequency ablation.

13:36  **1771. On The Development of Wave-Guide Constrained Magnetic Resonance Elastography**

Anthony Joseph Romano, Phillip J. Rossman, Joseph A. Bucaro, Richard L. Ehman

1Naval Research Laboratory, Washington, District of Columbia, USA; 2Mayo Clinic and Foundation, Rochester, Minnesota, USA

We present a novel extension of MRE measurement methods which is applicable in cases where the biological tissue under investigation is characterized by fiber bundles (i.e. muscle, neuronal pathways, etc.) leading to waveguide constrained propagation of elastic displacements. As an initial demonstration, clinical MRI was utilized to identify individual pathways within a fibrous stalk of celery, and 3-D MRE was performed throughout the volume containing the fibers for a measurement of the displacements. These displacements were projected onto the individual fiber paths, and dispersion images were obtained which portray velocity and attenuation information along the fiber.

13:37  **1772. MRE Determination of the Lame Constants by Simultaneous Visualization of P- and S-waves**

Bao Zhang, Jiachen Zhuo, Garth M. Beache

1University of Maryland Medical Center, Baltimore, Maryland, USA

Magnetic resonance elastography (MRE) estimation of shear modulus (s-wave) of biomaterials has been documented. We now report the simultaneous detection of the longitudinal (p-) and shear waves, which is necessary to completely specify the material properties of a solid. A periodic vibration was applied axially along a cylindrical phantom (6% gelatin; 50 Hz), resulting in a p-wave traveling along the axial direction, and an ortho-normal s-wave. P- and s-wave vibrations were encoded using axial motion-sensitization. Wave speeds and thus the 2 independent Lame constants were estimated. Measured Poisson ratio was 0.38±0.09 vs. 0.5, assumed for incompressible solids.

13:38  **1773. Bed-Type Oscillator for MR Elastography**

Takenori Oida, Yu Hong, Tetsuya Matsuda, Jun Okamoto, Takashi Azuma, Osamu Takizawa, Akira Amano, Sadami Tsutsumi

1Kyoto University, Kyoto, Japan; 2Siemens-Asahi Medical Technologies Ltd., Tokyo, Japan

In most MR elastography studies, a probe that contacted the object was used to provide oscillation. Since this oscillator contacted the objects with small area, the oscillation wave propagated from the small region. An oscillator with a large area of attachment would generate a flat wave and provide effective energy supply. In this paper, we propose a bed-type oscillator to yield large area of attachment. The experimental results of the phantom showed that this oscillator produced flat wave, and propagating shear wave is easy to observe in the MRE image of human calf obtained with this oscillator.

13:39  **1774. In Vivo Examination of Skeletal Muscle with MR Elastography**

Kai Uffmann, Stefan Maderswald, Serban Mateiescu, Waleed Ajaj, Craig J. Galban, Mark E. Ladd

1University Hospital Essen, Essen, Germany

MR Elastography is capable of determining skeletal muscle stiffness. To investigate individual long term changes of muscle elasticity, repeated examinations in two volunteers were performed. Additional examinations of four different muscles of the upper and lower extremities were performed in 12 healthy volunteers to initiate the generation of a database containing muscle stiffness values. The database is supposed to support diagnosis of diseases affecting muscle, due to muscle elasticity deviations.

13:40  **1775. Correlation of Diffusion Tensor and Strain Imaging in Ex Vivo Bovine Spinal Cord**

Robert Cary Welsh, Derek D. Steele, Thomas L. Chenevert

1University of Michigan, Ann Arbor, Michigan, USA

We present diffusion tensor and strain imaging data from an ex vivo bovine spinal cord phantom suggesting a correlation between tissue microstructure and macrostructure. The fractional anisotropy of the diffusion images are oriented along the white matter fibers. These fibrous structures change the strain image contrast depending upon their orientation with respect to a mechanical load.


Kai Uffmann, Mark E. Ladd

1University Hospital Essen, Essen, Germany

MR Elastography is a noninvasive method to measure tissue stiffness by introduction of mechanical oscillations into the tissue. To determine absolute elasticity values or even the elasticity tensor acquisitions of several phase images are required. A new method is presented allowing for reconstruction of only one phase image. Analysis of the algorithm is performed with test images containing different wave patterns concerning amplitude and wavelength. Additionally the influence of noise was examined. Elastograms are shown reconstructed from phase images acquired in a phantom of Agar Gel and in the biceps muscle in vivo.
Protein Kinase C (PKC)α, which is essential for cardiomyocyte growth, has been implicated in heart failure. We studied cardiac metabolism in PKCα-null knockout mice using proteomic and metabolomic analysis. Some glycolytic enzyme isozymes were absent or decreased in PKCα−/− hearts, whereas several lipid metabolism enzymes showed marked increases. NMR of the PKCα−/− heart extracts showed a significant decrease in the ratio of glycolytic (alanine+β-hydroxybutyrate) metabolic end products, when compared to controls. Combining the proteomic and metabolomic information, our data showed that loss of PKCα caused a metabolic shift from glycolytic to lipid metabolism in murine hearts.

Accumulation of Rb+ in heart and blood plasma was monitored by 87Rb-MRS during 60-min intravenous infusion of RbCl and adrenergic agonist, dobutamine into the open chest pigs in vivo. Dobutamine increased Rb+ uptake rate 2.5-fold, which was associated with adrenergic stimulation of the Na+/K+ ATPase, and increases in heart rate and coronary flow. Cardiac tissue to blood plasma Rb ratio did not change.

We previously used 87Rb-MRS to study regulation of potassium channels in rat hearts. In this work, we applied 87Rb-MRS to study K+ fluxes in normal (CD-1) mice. The Rb+ uptake was faster in mouse than in rat hearts, while efflux rates were comparable. Activators of KATP channels 2,4-dinitrophenol and P-1075 increased efflux rate by ~30%. These data provide background for studies of mice carrying mutations in KATP channels.

Obesity is epidemic in the United States and Europe, which may be associated with various forms of heart disease. We investigated MR methods for myocardial lipid assessment. Specifically, we assessed the relationship of MR signal to fat concentration on lipid phantoms with magnetic resonance spectroscopic imaging (MRSI). Using MRSI, both intramyocellular lipid (IMCL) and extramyocellular lipid (EMCL) could be assessed.

Factors affecting fatty acid oxidation in the potassium arrested heart were investigated. Fatty acid (FA) oxidation has been associated with postischemic myocardial injury. We evaluated the effects of myocardial oxygen consumption (MVO₂) and myocardial redox state on substrate oxidation by 13C MRS during normokalemic perfusion (N) and potassium arrest (PC). Increased MVO₂ augmented FA oxidation during PC. Altering the cytoplasmic redox state decreased FA oxidation during N perfusion. Changes in mitochondrial redox state increased FA oxidation during PC perfusion. MVO₂ and redox state affect myocardial substrate selection under N and PC conditions. Manipulation of myocardial redox state to suppress FA oxidation may be a useful strategy to limit myocardial reperfusion injury.
Investigations of the High-Energy Phosphate Cardiac Metabolism in Dilated Cardiomyopathy (DCM) by using $^{31}$P-MRS

Reinhard Rzanny1, Jürgen R. Reichenbach1, Andreas Hansch1, Jens-Peter Heyne1, Uwe Leder1, Werner A. Kaiser1
1Friedrich-Schiller-University, Jena, Thüringen, Germany

Patients with severe and moderate DCM were examined with $^{31}$P-MRS of the heart muscle. The results were compared to the left ventricular ejection fraction (LVEF) as an established parameter of disease severity to investigate the prognostic information of metabolic changes in cardiac high-energy phosphates. 15 patients with severe (mean age 50.0±12.1 years), 10 patients with moderate (mean age 50.6±10.5 years) DCM and 20 healthy controls (mean age 35.2±10.7 years) were examined with CSI at 1.5 T. The PCr/??-ATP ratios were significantly reduced in patients with severe DCM (LVEF<30%) and less but also significantly in patients with moderate DCM (LVEF>30%).

Peak-Combination HARP for Increased Reproducibility of Tagging Analysis

Salome Ryf1, Juerg Schwitter2, Jeffrey Tsao1, Anja Stuessi1, Peter Boesiger2
1University and ETH, Zuerich, Switzerland; 2University Hospital, Zuerich, Switzerland

HARP is a powerful tool to quantify myocardial motion, but it is susceptible to nonidealities such as B0 inhomogeneity. A method is introduced, which allows to correct for spurious phase by combining the signal of negative and positive peaks for the HARP evaluation. In a volunteer study, a better reproducibility is shown for data evaluated with peak combination HARP compared to the conventional HARP evaluation.

Artifact Reduction in HARP Stain Maps

Vijay Parthasarathy1, Jerry Ladd Prince1
1Johns Hopkins University, Baltimore, Maryland, USA

Harmonic Phase (HARP) strain maps have visible artifacts, often called zebra patterns, which both limit the accuracy and degrades the appearance of strain computations. The approach described here reduces this artifact by unwrapping the HARP phase and smoothing the unwrapped phase. In order to preserve strain resolution, the smoothing filter is designed to have the same size as the HARP bandpass filter. This approach is shown to reduce artifacts in cardiac images while simultaneously preserving transmural strain.

Comprehensive Assessment of Systolic Function in the Mouse Heart using Volumetric DENSE MRI

Florent C. Sureau1, Wesley D. Gilson1, Zequan Yang1, Brent A. French1, Frederick H. Epstein1
1University of Virginia, Charlottesville, Virginia, USA

In the present study we developed a volumetric DENSE imaging sequence with three-dimensional displacement encoding to comprehensively measure regional myocardial mechanics across the entire mouse heart. Mice were imaged on a 4.7T system, and results demonstrate the ability to quantify 3D myocardial displacement, strain, twist, and torsion with a spatial resolution of 0.23 x 0.23 x 0.58 mm3.

Characterization of Transmural Strain Gradients in Canine Myocardium

Daniel B. Ennis1, J. Andrew Derbyshire2, Elliot R. McVeigh2
1Johns Hopkins University, Baltimore, Maryland, USA; 2National Institutes of Health, Bethesda, Maryland, USA

Improvements in a high resolution respiratory and cardiac gated magnetic resonance 3D fast gradient echo imaging sequence provided tagged images for quantitative analysis of transmural function in canines. The average wall thickness of ~10mm results in a minimum of 3 analyzable tags across the transmural extent of the wall. Quantitative analysis shows circumferential strains decreasing from ~0.09±0.02 near the epicardium to ~0.18±0.03 near the endocardium. Radially directed strains are shown to increase from 0.21±0.05 at the epicardium to 0.31±0.06 at the sub-endocardium.

Interpreting Myocardial Morphology and Function from DENSE MRI Data Based on Fluid Mechanics Concepts

Nikoo Saber1, Morteza Gharib1, Han Wen2, Gerald Buckberg3, Brian Ross4
1California Institute of Technology, Pasadena, California, USA; 2National Institutes of Health, Bethesda, Maryland, USA; 3UCLA School of Medicine, Los Angeles, California, USA; 4Huntington Medical Research Institutes, Pasadena, California, USA

We aim to identify myocardial fiber orientations and wall dynamics based on the Torrent-Guasp hypothesis of the helical heart, predominantly using the DENSE MRI technique. The latter is a phase contrast method for measuring the Lagrangian displacement fields of the myocardial wall in vivo, providing a high spatial and temporal density of measurements in the myocardium via stimulated echoes, while the image is always acquired at the same time point in the cardiac cycle. We also determine wall point trajectories from DENSE data via the application of the stream function concept adapted to the myocardium displacement field.
A multi-slice DENSE pulse sequence with 3D displacement-encoding was developed for mouse heart imaging at high spatial resolution. The sequence was used to study myocardial function at baseline and after acute myocardial infarction. Using this technique, a comprehensive assessment of 3D myocardial mechanics was achieved in mice in under 1 hour.

Characterization of myocardial deformation in genetically manipulated mouse models with MR tagging provides new opportunities for elucidating the molecular mechanisms of cardiac function. A HARP-based partial k-space sampling approach was developed for fast measurement of the cardiac strain field in mice. The method samples all the spectral peaks in the low-frequency part of the k-space and greatly reduces image acquisition time without compromising image quality. Validation study exhibited strong correlation with traditional full k-space sampling method. This method provides a practical approach for fast imaging of myocardial strain in small animals.

MR tagging was performed to assess the cardiac functional phenotype of dystrobrevin-knockout (adbn-/-) mice. Significant differences were observed in terms of twist and strain in adbn-/- mice, despite the lack of differences in global function and anatomy. Although adbn-/- mice developed similar patterns of lesions as mdx mice, the enhancement in torsion and strain in adbn-/- mice differed from that of mdx mice, which exhibited reduced torsion. The exact mechanisms underlying these differences remain to be elucidated. Our study indicates that functional adaptations to genetic mutations exhibit markedly different phenotypes in mdx and adbn-/- mice depending on the specific mutation.

We studied five mice at baseline and 1 day, 7 days and 28 days after induction of a reproducible, large, antero-lateral MI. Tags were tracked in all images and a 3D finite element model of the LV was used to reconstruct the 3D deformation and strain. In the infarcted region, 3D strains were markedly reduced at day 1 with little change therafter. In non-infarcted lateral regions function was deminished at day 1 and recovered thereafter. These results will be useful in determining the effect of genetic manipulation and/or pharmacologic therapy on post-MI remodeling.

Myocardial tagging provides a quantitative technique for assessing regional myocardial wall motion. Endocardial border detection can be difficult in tagged images due to the presence of tags and low spatial contrast to-blood contrast. Also, the tagged MR images pose challenges for both manual and automated segmentation techniques. Gabor filters have been used extensively in image processing techniques and have been recently used for detection of myocardial tags. The purpose of this study was to use 2D Gabor filters to suppress the tags in the myocardium, and enhance the blood-to-myocardium contrast.

The aim is to compute the 3D myocardial strain tensor, based on improved HARP motion tracking in short-axis and long-axis image planes. In SA slices, through-plane motion is handled by defining “inactive” tracking points outside the myocardium, estimating their displacement, and making them “active” when entering the myocardial contours in order to track them on the following time frames. This method yields a complete 3D myocardial strain analysis with high temporal resolution. No user interaction is required during tracking and therefore this method offers prospects for clinical applications that require high temporal resolution, such as asynchronous contraction and diastolic dysfunction.
Displacement-encoding with stimulated echoes (DENSE) and harmonic phase imaging are quantitative MRI techniques for assessing intramyocardial function without the need for explicit tag detection. However, DENSE and HARP produce relatively low signal-to-noise ratio (SNR) because of the 50% signal loss inherent to stimulated echoes or bandpass filtering only one of the acquired echoes, respectively. The purpose of this study was to develop a technique for increasing the SNR in DENSE MRI. This technique is based on the SNR advantage of extracting two sub-sampled phase images with uncorrelated noise from a complex CSPAMM image and combining them during image reconstruction.

Myocardial motion may be reconstructed by detection and tracking of tag points in cine cardiac images. Our aim is to speed up and fully automate quantitative motion analysis of tagged cardiac MR images for routine clinical use. We extend here one of the previous approaches for automatic myocardial localization [Isci & Ozturk, Proc. ISMRM 2002], which utilizes a HARP based tag extraction and myocardial segmentation using harmonic phase unwrapping consistency along expected semicircular paths. We also combined myocardial and tag localizations methods with a B-spline based motion field fitting technique and obtained a complete heart motion evaluation package.

Harmonic phase (HARP) MRI is used to measure myocardial motion and strain from tagged MR images. The Fourier resolution of the bandpass filter HARP uses to extract harmonic peaks in Fourier space correctly characterizes the resolution of anatomical images computed using HARP. The resolution of HARP strain images is not easily described, however, and cannot be inferred from this same theory. We propose a new characterization of strain resolution, and use results from communications theory to show that the resolution of HARP strain is, nevertheless, nearly the same as the intrinsic Fourier resolution.

Tagged images are characterized by spectral side-peaks (harmonics) in the frequency domain. While image domain measures, such as tag contrast, have been well studied, few studies have investigated the frequency domain. Given the recent interest in efficient tagging analysis methods that exploit the 1st harmonic representation in the frequency domain, we investigated a new index, 1st harmonic intensity decay. Human myocardial SPAMM acquisitions, with varying temporal delays, revealed that the frequency domain index was more sensitive than image domain tag contrast for tag temporal characterization. Further analysis is needed to determine the relation to physiology.

Angiotensin-converting enzyme (ACE) inhibition has been use to reduce incidence of congestive heart disease. However, murine models of heart disease (e.g. aortic banding (AB) and myocardial infarction (MI)) have not been well characterized. In this study, we assess the long-term effects of attenuating remodeling and function by cardiac MRI. Treatment with captopril improved survival after MI and TAB by 140 and 70.3%, respectively (p<0.01). Treatment resulted in increased EF vs vehicle in the MI animals and reduced LV mass in the TAB animals. These results illustrate that beneficial effects of captopril in murine models of heart failure may be monitored.

An in vivo MRI technique is demonstrated to map the cyclic change of myocardial blood volume during the cardiac cycle. The method was based on the dominant T2* shortening effect of MION susceptibility perturbation in myocardium. The technique is demonstrated with mouse hearts in vivo at 9.4T using steady-state pre- and post-contrast cine images. High-resolution MBV maps at various cardiac points were obtained. The analysis showed a general MBV decrease from end-diastole to end-systole. Percent changes were 18.2±6.6% in the lateral wall and 24.7±3.1% in the interventricular septum. The heterogeneous characteristics of MBV transmural distribution were also reported.
13:47  **1801.** Assessment of Cardiac Function in the Rat Using an 11.75 T System with a Vertical Bore  
David John Tyler*, Craig Lygate*, Paul Cassidy*, Juergen Schneider*, Stefan Neubauer*, Kieran Clarke*  
*University of Oxford, Oxford, Oxfordshire, UK

Many experimental MR centres are equipped with high field magnets, which have a vertical bore. Assessment of rat cardiac function using cine MRI in these systems could enable the acquisition of images with a higher spatial and temporal resolution. In this work we demonstrate that there are no haemodynamic effects on the rat from the vertical position and we further demonstrate the feasibility of acquiring in vivo images at a higher spatial and temporal resolution than has previously been reported.

13:48  **1802.** Automatic Segmentation of LV Volumes in Murine Cine MR Data using an EM-MRF Algorithm with Partial Volume Correction  
Jürgen E. Schneider*, Clare Jackson*, Xujiang Ye*, Stefan Neubauer*, J. Alison Noble*  
*Oxford University, Oxford, Oxon, UK

Genetically modified mice are commonly used as models for human cardiac disease, and high-resolution cine magnetic resonance imaging has been applied successfully to quantify myocardial mass and function in mice. In order to assess cardiac function, left ventricular volumes are commonly segmented manually, which involves substantial user-time. We developed a novel approach based on an expectation-maximization (EM) algorithm, combined with a Markov random field (MRF) model and partial volume correction. The application to mouse cine data allowed not only the measurement of EDV and ESV, but also to construct the time-volume curve for the left ventricle.

13:49  **1803.** A Fully Automated Registration-Based Technique for Segmentation of the Left Ventricle from Cardiac MRI  
Piotr J. Slomka*, Usaf Aladl, Tejas Mehta*, Daniel S. Berman*, Guido Germano*  
*University of Western Ontario, London, Ontario, Canada

Fully automatic segmentation of the left ventricle from cardiac MRI has been developed. The endocardial contour is found by motion detection (calculated from the voxel intensity changes across the cardiac cycle) and optimal threshold determination. Epicardial contours are found by a novel contour-to-image registration technique that automatically aligns Hermite curves with images. Views from multiple orientations are used in an integrated fashion. Both Fast Spoiled Gradient Echo and True-FISP techniques have been evaluated. The average difference between the manually and automatically determined end diastolic and end systolic volumes was found to be 15.3±6.8 ml and 4.6±2.6 ml respectively.

13:50  **1804.** Towards Image-Based Registration of 2D Real-Time Images to 3D Pre-Procedural Images for MRI Guidance of Endovascular Cardiac Procedures  
Renata Smolikova-Wachowiak*, Mark Paul Wachowiak*, Maria Drangova*  
*Robarts Research Institute, London, Ontario, Canada

MRI guidance of endovascular procedures involves the use of relatively low quality 2D real-time images. Although these images may be adequate to visualize the endovascular tools, it is often difficult to orient the slice within the three-dimensional volume of the heart. This study demonstrates the feasibility of registering 2D MR slices to single-phase pre-procedural volumes without preprocessing. Images acquired at different phases may be satisfactorily registered using rigid transformations. The results demonstrate that, although higher resolution 2D images do result in a higher registration success rate, satisfactory registration of low resolution scans to pre-procedural volumes can be attained.

13:51  **1805.** Comparison of Low Molecular Weight and USPIO Contrast Agents for Detection of Rejecting Transplanted Hearts  
Eva Penno*, Cecilia Johnsson*, Lars Johannson*, Håkan Ahlström*  
*Uppsala University Hospital, Uppsala, Sweden

The purpose of the study was to compare a low molecular weight gadolinium-chelate and two different USPIO contrast agents for MR, and determine which one could discriminate the best between acutely rejecting and non-rejecting transplanted hearts in the rat. Syngeneic and allogeneic heterotopic heart transplantsations were performed. T1 weighed MR sequences were performed following contrast agents injection. Permeability assessments were made for USPIO groups and perfusion assessments for the gadolinium chelate groups. Both USPIOs were able to discriminate rejecting from non-rejecting transplanted hearts without overlapping between the groups. No difference was seen between the groups that were injected with gadolinium-chelates.

13:52  **1806.** Three-Dimensional Cardiac Image Segmentation with Sparsely-Sampled Datasets: Cardiac Image Modeling versus Numerical Integration  
Scott Edward Yochim*, Maria Vakulenko*, John William Grinstead*, Paul Finn*  
*David Geffen School of Medicine at UCLA, Los Angeles, California, USA

In this abstract we compare the rate of convergence of two computer algorithms for the assessment of left ventricular mass and left ventricular volumes as the number of available image slices on cine-MRI is incremented from sparse to full. In this way, the minimum amount of spatial sampling necessary for accurate evaluation of global cardiac functional parameters is determined. This comparison demonstrates that Cardiac Image Modeling converges to an end point with fewer images than does Argus, a numerical integration algorithm, for both normal and abnormal patients.
Cardiac Function in Children and Adults

Room I  Wednesday 13:30 - 15:30

13:30  1808. Black Blood Imaging Using the Simultaneous Multiple Volume Navigator Method
Minjie Wu1
1University of Pittsburgh, Pittsburgh, Pennsylvania, USA

The simultaneous multiple volume (SMV) approach allows the whole motion range or the whole scan time to be used for the final image reconstruction by simultaneously acquiring different image volumes at different motion states. By combining black blood MR imaging with SMV acquisition, we can significantly increase the scan efficiency of navigator methods while maintaining the effectiveness of motion suppression.

13:31  1809. SSFP Cardiac Cine Imaging with High Blood - Myocardium Contrast at 3T
Bernd André Jung1, Dominik Paul1, Jürgen Hennig1
1University Hospital, Freiburg, Germany

SSFP sequences with high flip angles (60-70°) provide excellent contrast for the assessment of cardiac function at 1.5T. However, at 3T, the flip angle has to be significantly reduced (<45°) because the SAR increases with the square of the field strength. As a consequence, the contrast between blood and myocardium decreases. This work investigates a method for acquiring cardiac cine images with increased contrast compared to the conventional sequence with the highest allowed flip angle. Instead, it uses variable flip angles to weight k-space over the heartbeats of a breathhold period with an additional "a-half-step" preparation to avoid signal oscillations.

Christina Pinto1, Tim Carroll1, Richard McCarthy1, Reed Omary1, Lon Simonetti2, James Carr1
1Northwestern University Medical School, Chicago, Illinois, USA; 2Siemens Medical Systems, Chicago, Illinois, USA

First pass imaging of the heart is typically carried out to evaluate myocardial perfusion. Higher spatial resolution imaging is generally required to detect small intracardiac vascular abnormalities, such as shunts. We investigated the utility of first pass IR TrueFISP for evaluating intracardiac vascular lesions. ECG-triggering was used and 1 image was acquired per heartbeat. 22 patients were studied. All of the abnormalities were detected. Time-intensity curves demonstrated an abnormal early intensity peak in the shunt cases. First pass single-shot inversion recovery TrueFISP is accurate in detecting intracardiac vascular abnormalities where anatomic detail and flow dynamics are essential for complete characterization.

13:33  1811. T1-Weighted and Diffusion-Weighted Line Scan MR Imaging of the Human Heart
Hajime Sakuma1, Stephan E. Maier2
1Mie University Hospital, Tsu, Mie, Japan; 2Brigham and Women's Hospital, Boston, Massachusetts, USA

T1 weighted and diffusion weighted (b=200 s/mm²) line scan MR images were obtained in 5 volunteers. T1 weighted line scan MRI provided an excellent delineation of cardiac morphology. The use of velocity compensated diffusion gradients significantly reduced the influence of bulk motion and reasonable ADC value was measured in the chest wall muscle (0.39±0.02 µm²/ms with diffusion gradient perpendicular to fibers). The averaged ADC of the myocardium obtained by velocity compensated diffusion gradients (1.90±0.68µm²/ms) was significantly lower than that by conventional diffusion gradients (p<0.001). However, further improvement is required for an accurate quantification of ADC and diffusion tensor in human myocardium.

Kai-Uwe Waltering1, Peter Hunold1, Oliver Bruder2, Thomas Schlosser1, Markus Jochims2, Jörg Barkhausen1
1University Hospital, Essen, NRW, Germany; 2Elisabeth Hospital, Essen, NRW, Germany

Prospectively triggered steady state free precession sequences are the state of the art technique for the assessment of cardiac function. However, a recently developed triggered-retrogated SSFP sequence combining prospective triggering and retrospective gating offers important advantages. Due to retrospective gating the sequences covers the entire cardiac cycle. Artifacts and blurring caused by arrhythmia can be reduced by arrhythmia rejection, resulting in better image quality in patients with atrial fibrillation and extrasystoles. Furthermore, in patients with sinus rhythm the sequence improves the workflow, because there is no need to adjust the acquisition window to the patients’ heart rate.

Normally, clinicians define cardiac contours in the end diastole and the end systole, linearly estimating cardiac parameters such as stroke volume, ejection fraction, etc. In this abstract, we introduce a robust and efficient algorithm to define cardiac contours automatically through cardiac cycle. Our method has been tested on 34 subjects, including 20 volunteers and 14 cardiac failure patients. Mean LV end diastolic volume in each of the scans was measured by planimetry (manual/proposed)=177.3±176.55ml, p=0.48. LV end systolic volume=82.10/84.32ml, p=0.33. Mean LV ejection fraction =0.48/ 0.48, p=0.25. The method therefore appears to be promising as an accurate cardiac boundary tracking tool.

An Efficient and Robust Method to Determine Cardiac Contours in Time-Series MRI Images
Gao Gang1, Paul William Cockshott1, Thomas Nicolas Martin1, John Edward Foster1, Henry Dargie1, Alex Elliott1, Bjoern Aaris Groening1
1Glasgow University, Glasgow, Scotland, UK

Prospectively triggered steady state free precession sequences are the state of the art technique for the assessment of cardiac function. However, a recently developed triggered-retrogated SSFP sequence combining prospective triggering and retrospective gating offers important advantages. Due to retrospective gating the sequences covers the entire cardiac cycle. Artifacts and blurring caused by arrhythmia can be reduced by arrhythmia rejection, resulting in better image quality in patients with atrial fibrillation and extrasystoles. Furthermore, in patients with sinus rhythm the sequence improves the workflow, because there is no need to adjust the acquisition window to the patients’ heart rate.

1 University Hospital, Essen, NRW, Germany; 2Elisabeth Hospital, Essen, NRW, Germany
13:35 1813. Improved Cardiac Cine Imaging at 3T Using Modulated Flip Angles
Vibhas S. Deshpande1, Paul Finn2, Gerhard Laub3
1Siemens Medical Solutions, Los Angeles, California, USA; 2University of California, Los Angeles, California, USA

Imaging at 3T offers SNR benefits over 1.5T. On the other hand, Specific absorption rate (SAR) is increased four-fold simultaneously. Cardiac cine imaging using trueFISP relies on high flip angles to generate high blood signal and high blood-myocardial contrast. However, SAR places limits on the maximum flip angle achievable at 3T, which is an impediment for trueFISP cine imaging. In this work, we propose modulating the flip angles in k-space such that higher flip angles are used in the center of k-space to increase signal and contrast by compromising flip angles in higher k-space, while retaining the SAR within limits.

13:36 1814. Simultaneous Use of Double-IR and Triple-IR FSE Imaging Techniques Is a Sensitive Approach for Diagnosis and Early Detection of Arrhythmogenic Right Ventricular Cardiomyopathy
Daowen Wang1, Liming Xia1, Jiangtao Yan1, Chengwei Liu1, Xinshan Cheng1, Till Barnighausen1, Wenling Zhu2, Roxanne Deslauriers2, Ganghong Tian2
1Tongji Medical College of Huazhong University of Science and Technology, Wuhan, Hubei, People's Republic of China; 2National Research Council of Canada, Winnipeg, Manitoba, Canada

This study determined whether simultaneous use of double IR-FSE and triple IR-FSE imaging techniques is a sensitive approach for diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia (ARVC). We found that thin and irregular right ventricular wall on triple IR-FSE images seems to be a more sensitive MR indication of the disease than RV enlargement. We also found that comparative analysis of DIR-FSE and TIR-FSE images provides reliable information on the structure and tissue components of the RV wall. We conclude that simultaneous use of the two imaging techniques is a sensitive approach for early detection and diagnosis of ARVC.

13:37 1815. Efficacy of MR Indicators for Cardiac Resynchronization Therapy (CRT)
Andrew Lee1, Alexander Peter Lin1, Cathleen M. Enriquez2, Benjamin England1, Patrick Colletti1, Fernando Roth1, Mayer Rashian1, Mark Myers1, Brian Ross1
1Huntington Medical Research Institutes, Pasadena, California, USA

Cardiac MRI with MASS and HARP analysis was performed in 10 patients with echo-verified dilated cardiomyopathy. Significant wall motion abnormalities quantified in three ways: asymmetry, asynchrony and circumferential strain, readily distinguished DCM from controls. Cardiac MRI also defined candidates for cardiac resynchronization therapy CRT and promises to be more predictive of clinical outcome than ECG criteria. Since currently 30% of CRT do not benefit, we suggest adding Cardiac MRI with MASS and HARP to selection criteria in elderly DCM.

13:38 1816. New Approach for Assessment of Human Cardiac Shunts using Rapid 1H MR T1 Mapping in Combination with Inhaled Pure Oxygen
Tungte Wang1, Alexandra Rauch1, Christian M. Wacker1, Peter Schanzenbächer1, Matthias Nahrendorf1, Eberhard D. Pracht1, Johannes F. T. Arnold1, Wolfgang R. Bauer1, Peter M. Jakob1
1University of Würzburg, Würzburg, Bavaria, Germany

A new approach for assessment of cardiac shunts using rapid oxygen-enhanced 1H MR T1 mapping has been successfully demonstrated in three patients. The fact that oxygen physically dissolved in blood is weakly paramagnetic and acts as a T1-shortening contrast agent was exploited. The abnormally increased oxygen enhancement in the venous blood and the abnormally decreased oxygen enhancement in the arterial blood in heart chambers or great vessels were measured. The results were confirmed by the catheterization. The proposed method is very sensitive to oxygen content in blood and has the potential to detect all kinds of cardiac shunts.

13:39 1817. Late Deterioration of Right Ventricular Dilatation after Transannular Patching in Total Repair of Tetralogy of Fallot
Alexander van Straaten1, Hubert W Vliegen1, Mark G Hazekamp1, Albert de Roos1
1Leiden University Medical Center, Leiden, Zuid-Holland, Netherlands

Tetralogy of Fallot is the most common cyanotic congenital heart disease worldwide. Although long-term survival is excellent, pulmonary regurgitation related adverse effects occur in many patients. In the present study we investigated the influence of transannular patching during total repair on long-term right ventricular dilatation. Our results indicate that the use of a transannular patch is associated with higher pulmonary regurgitant fractions and increasing right ventricular dilatation late after repair, whereas patients who did not receive a transannular patch had less pulmonary regurgitation and did not show late deterioration of right ventricular size.
**Poster Sessions**


Erik Schelbert1, Alan H. Stolpen1, Honghai Zhang2, Michael Dixon1, Liping Bu1, Milan Sonka2, Stephanie Munns1, Thomas Scholz2, Larry Mahoney1, Shuping Ge1

1University of Iowa College of Medicine, Iowa City, Iowa, USA; 2University of Iowa, Iowa City, Iowa, USA

We assessed the agreement of flow-based measurements of left ventricular stroke volume (LVSV) in children by two noninvasive techniques: 2D cine phase contrast MRI (PCMR) and real time 3D Doppler echocardiography (RT3DE), a new technique that measures flow in an angle-independent manner by projecting the raw Doppler velocity information onto a curved surface. 12 normal children were studied. RT3DE and PCMRI flow-based measurements of LVSV showed good agreement and correlated well with volumetric MRI methods.


Michael P. Dixon1, Erik Schelbert1, Stephanie Munns1, Honghai Zhang1, Milan Sonka1, Shuping Ge1, Alan Stolpen1

1University of Iowa, Iowa City, Iowa, USA

Measurement of ventricular stroke volume by 2D cine true steady state free precession gradient echo MRI provides important functional information about the heart. An alternative method to obtain stroke volume is to measure flow per cycle in the aorta or pulmonary artery by 2D cine phase contrast MRI. This study compares the two methods in normal, healthy children as a reference for further studies in patients with congenital heart disease.

**13:42** 1820. Retrospectively-Gated, Respiratory-Triggered SSFP Sequence for Assessing LV Function in Freely-Breathing Pediatric Patients

Taylor Ching1, Rajesh Krishnamurthy1, Giles Wesley Vick, III1, John P. Kovalchik1, Raja Muthupillai1

1Texas Children's Hospital, Houston, Texas, USA; 2Baylor College of Medicine, Houston, Texas, USA

SSFP techniques have been used in adults in a breath-held setting to assess LV function. However, SSFP sequences are sensitive to perturbations to the steady state either due to field inhomogeneities or bulk motion. Pediatric patients often can not breathhold. The purpose of the study is to test the feasibility of using a SSFP sequence combining retrospective cardiac gating and respiratory triggering to assess left ventricular (LV) function in freely-breathing pediatric patients. The sequence was optimized in volunteer studies, and initial clinical results show that it is feasible to use this modified SSFP cine sequence to assess pediatric LV function.

**13:43** 1821. Interventricular Mechanical Asynchrony Due to Right Ventricular Pressure Overload in Pulmonary Hypertension

J. T. Marcus1, J. J. Zwanenburg1, T. Gan1, A. Boonstra1, J. P. Kuiper1, A. Vonk Noordegraaf1

1VU University Medical Center, Amsterdam, Noord Holland, Netherlands

In 7 pulmonary hypertension patients, the myocardial shortening in the right (RV) and left ventricle (LV) was measured with high temporal resolution (14 ms) MRI myocardial tagging. Harmonic phase strain analysis yielded functional images of myocardial shortening at the mid-ventricular short-axis plane, in each temporal frame of the cardiac cycle. The time to peak shortening in the RV lateral wall was 100 ± 43 ms later than in the LV lateral wall (p<0.001). In pulmonary hypertension, this prolonged RV systolic contraction contributes to leftward ventricular septal bowing, and impairs LV diastolic filling.

**13:44** 1822. Evaluation of Left Ventricular Contractility in Patients with Antero-Septal Myocardial Infarction during Clinical Treatment Follow-Up: Evaluation by Magnetic Resonance Imaging

Sergio Domingos Florenzano1, Jose Rodrigues Parga1, Carlos Eduardo Rochitte2, Luiz Francisco Avila2, Jose Antonio Ramirez1, Claudio Campi Castro1

1Heart Institute, Sao Paulo, Brazil; 2Heart Institute (InCor) -University of Sao Paulo Medical School, Sao Paulo, Brazil, Sao Paulo, Brazil

MRI tagging (MRI-T) with dobutamine assessed LV function in patients with antero-septal myocardial infarction. MRI-T was performed at rest/low doses of dobutamine (10 mcg/kg/ml) in 23 patients. Studies were evaluated at protocol inclusion (E1), after 4 months (E2) and 10 months (E3). Images were acquired at LV short-axis. EDV, ESV, EF, global maximum shortening (MS) and circumferential shortening (CS) index were analyzed using Findtags. No differences in EDV, ESV and EF. Improvement in CS (p=0,013) and MS (p=0,007) was found from E1, E2, and E3. MRI-T showed quantitative improvement in LV function, being an excellent tool to monitor medical treatment.

**13:45** 1823. Vorticity Imaging of Diastolic Dysfunction by Phase Contrast MRI

Edward A. Gill1, William Sean Kerwin1

1University of Washington, Seattle, Washington, USA

Phase Contrast MRI is used to map the flow field of the left ventricle during diastolic filling and shows the absence of normal ventricular structures in patients with heart failure related to diastolic dysfunction. To visualize these differences, a unique combination of phase contrast MRI accelerated by UNFOLD and color-coded display techniques were developed. The resulting display shows distinct difference between normal and abnormal function, which may prove clinically relevant for understanding heart failure.
**13:46 1824. Importance of MR Vendor Specific Optimization of Automated Left Ventricular Contour Detection**

Emmanuelle Angelié1, Rob J. van der Geest1, Patrick J.H. de Koning1, Johan H.C. Reiber1

1Leiden University Medical Center, Leiden, Netherlands

In previous work we demonstrated the importance of optimizing the settings of the automated left ventricular contour detection parameters of the MASS software package for images obtained with specific pulse sequences such as Gradient Echo and Steady State Free Precession (SSFP) sequences (1). In this work we studied whether specific optimization of the contour detection parameters is needed for SSFP images obtained from MR systems of three different vendors. The results of this study indicate that optimization for a specific MR system results in improved automated contour detection performance.

**13:47 1825. T2-Prepared TrueFISP : Application to Myocardial BOLD Contrast Imaging**

Teng-Yi Huang1, Kenneth K. Kwong1, Hsiao-Wen Chuang2, Brigitte P. Poncelet1

1Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA; 2Department of Electrical Engineering, Taipei, Taiwan, Taiwan

T2-prepared TrueFISP, which combines driven equilibrium T2 magnetization preparation and ECG-triggered segmented TrueFISP, has been shown to be practical to assess myocardial T2 value change induced by BOLD effect in several heart beats. In our study, ECG-triggered T2 preparation followed by continuous transient-state TrueFISP readout with particular phase-encoding order was proposed to acquire T2-weighted myocardial images in one heart beat. Comparison of different T2 preparation schemes was also investigated. In our preliminary result, we concluded that T2-prepared TrueFISP could be done in a single heart beat without prominent motion artifacts.

**13:48 1826. Myocardial BOLD Imaging: Comparison between TrueFISP and TSE Sequences**

Haosen Zhang1, Steve Shea2, Robert J. Gropler1, Jie Zheng1

1Washington University School of Medicine, Saint Louis, Missouri, USA; 2Northwestern University, Chicago, Illinois, USA

Pesudo T2 map acquired from the T2-prepared trueFISP image was compared with the apparent T2 map acquired with turbo spin echo (TSE) at the same slice location at baseline and during pharmacological hyperemia. A close match (low T2) was found between the pseudo and apparent T2 map in the myocardial area supplied by stenotic coronary artery and a higher sensitivity of the dependence of oxygen change was observed in the pseudo T2 map. These results indicate that multi-slice T2 prepared TrueFISP image can serve as a pilot scan to localize myocardial area associated with coronary artery disease (CAD).

**Myocardial Viability**

Room I  Thursday 13:30 - 15:30

**13:30 1827. Comparison of New Late Enhancement MR Imaging Techniques for Myocardial Infarction Lesion Assessment at 1.5 T**

Pierre Croisille1, Magalie Viallon2, Alexis Jacquier3, Filipo Civaia4, Carmen Rotaru1, Vincent Dor4, Didier Revel1

1Hôpital Cardiologique L.Pradel, Lyon, France; 2Siemens Medical Solutions, Paris, France; 3CHU Timone, Marseille, France; 4Centre Cardio-Thoracique, Monaco, Monaco

Differentiation between injured non-viable from normal myocardium using the delayed enhancement technique relies on inversion-recovery (IR) gradient-echo sequences. Our aim was to compare qualitatively and quantitatively in a phantom and clinical studies the newly available IR techniques (3D/2D; TurboFlash/TrueFISP/PSIR; Singleshot/Segmented approaches) for late enhancement characterisation of non viable infarcted myocardium.


Amar P. Singh1, Giovanni Salanitri1, Thomas Holly1, Elizabeth Krupinski2, Frederick Scott Pereles1

1Northwestern University, Feinberg School of Medicine, Chicago, Illinois, USA; 2The University of Arizona, Tucson, Arizona, USA

In a study of 40 patients, we investigated whether a non-breath-held inversion-recovery balanced gradient echo single-shot sequence and a breath-held 3D inversion-recovery gradient echo sequence are as accurate at determining myocardial viability as the standard breath-held two-dimensional inversion-recovery spoiled gradient echo technique.
We evaluated the feasibility of myocardial infarction data acquisition at 3 Tesla in humans. 14 consecutive patients who had suffered clinically proven myocardial infarction were examined on a 3.0T scanner. CE images were acquired 10 min after injection of 0.2 mmol/kg Gd-DTPA using an inversion recovery Turbo FLASH sequence. The percent signal intensity elevation in the infarcted myocardium and image contrast-to-noise ratios were determined. Mean percent signal intensity elevation in the infarcted myocardium was 1107±87%, the mean CNR 36.0±7.3. CE imaging of myocardial infarction using a segmented inversion-recovery turbo FLASH technique on a 3.0T system was shown to be feasible.

The aim of our study was to investigate the optimum time-point after contrast administration for the assessment of the ‘late enhancement’ area and the area of no-reflow zones in patients with acute myocardial infarction using a single shot inversion recovery steady state free precession sequence. Our data indicate that measurements of the no-reflow area should be performed immediately after contrast injection with fast techniques because the extent decreases over time, whereas scanning to detect ‘late enhancement’ requires a delay of at least 10 minutes after contrast injection.

Our goal was to compare the cardiac magnetic resonance characteristics of patients with community acquired myocarditis to those of patients with interleukin-2 myocarditis. We imaged 7 patients with suspected viral myocarditis and 5 patients with recent interleukin-2 therapy and myocardial injury. Imaging consisted of an assessment of myocardial volumes and function as well as the pattern of delayed enhancement post gadolinium. In all patients, we found a pattern of delayed enhancement which spared the subendocardium. On follow-up scans, improvement in cardiac function and the extent of delayed enhancement occurred only in the suspected viral myocarditis group.

Myocardial delayed enhancement was detected by Gd-enhanced segmented inversion-recovery MRI in 48% of patients with heart failure due to nonischemic dilated cardiomyopathy and the severity of myocardial delayed enhancement was related with cardiovascular mortality.

Gd-enhanced delayed hyperenhancement imaging was performed with a radial acquisition using a modified data acquisition order and reconstruction method which provided improved T1-weighting. The effectiveness of 180° preparation pulse for radial imaging was enhanced by collecting interleaved projection sets weighted such that central k-space contained only data collected from a smaller temporal aperture than outer k-space. These images had improved contrast compared to unweighted images. This method broadens the range of applications for radial acquisition in the heart by providing for effective preparation pulses.

A subtraction technique utilizing images at a short and long TI times is used to improve the contrast between the encardial borders of the infarcted zone and the ventricular blood pool while maintaining infarct-normal myocardial contrast. By subtracting the short TI time image from the long TI time image, ventricular blood signal is markedly reduced while maintaining a high signal intensity level from the infarcted zone. Normal myocardial signal is also further reduced using this approach. The technique was validated in dogs with reperfused myocardial infarctions.
**Assessment of Myocardial Viability using Contrast Enhanced MRI – Comparison of Gd-DTPA and Gd-BOPTA**

Thomas Schlosser¹, Peter Hunold¹, Sandra Massing¹, Kai-Uwe Waltering¹, Christoph U. Herborn¹, Jörg Barkhausen¹  
¹University Hospital Essen, Essen, NRW, Germany

We compared Gd-BOPTA and Gd-DTPA for the assessment of myocardial viability in patients with chronic myocardial infarction. MRI was performed twice in 15 patients using either Gd-BOPTA or Gd-DTPA. Analysis of T1-values showed significantly lower values for Gd-BOPTA in the infarcted and non-infarcted myocardium compared to Gd-DTPA. CNR between infarcted and normal myocardium was higher in the Gd-BOPTA data sets, but Gd-DTPA permitted better differentiation between the infarcted myocardium and the LV cavity because 15 minutes after injection of Gd-BOPTA the LV cavity was still isointense or slightly hyperintense compared to the infarcted tissue.

**Determining Tissue Kinetics of Gd(ABE-DTTA), an Infarct-Avid, Persistent Contrast-Agent in Canine Myocardial Infarction**

Pál Surányi¹, Pál Kiss¹, Brigitta C. Brott¹, Tamás Simor¹, Ada Elgavish¹, Gabriel A. Elgavish¹  
¹University of Alabama at Birmingham, Birmingham, Alabama, USA

ceMRI detects viability following myocardial infarction. Accurate T1-mapping is possible only with a multiple-T1 inversion-recovery approach. This is achievable only with a contrast-agent sufficiently long-lived in the myocardium. Tissue-kinetics and infarct-specificity of such a persistent-contrast-agent (PCA), Gd(ABE-DTTA) were studied in-vivo in a closed-chest canine model of reperfused infarct, using pixel-by-pixel T1-mapping. With one dose of PCA (0.05mmol/kg), good infarct visualization was demonstrated from 24h through 144h after administration. Peak myocardial R1 contrast was observed at 72 hours, with R1s of 2.5s⁻¹ and 1.18s⁻¹, in infarcted and normal myocardium, respectively. PCA accumulation into infarct was validated with TTC-staining, and tissue gadolinium content determination.

**Myocardial Perfusion: Techniques and Interpretation**

Room J  Monday 14:00 - 16:00

**Method for Multi-Slice Quantitative Measurement of Myocardial Perfusion**

Glenn Reynolds¹, Raymond Kwong², Kent Yucel², Thomas Foo¹  
¹GE Medical Systems, Waukesha, Wisconsin, USA; ²Brigham and Womens Hospital, Boston, Massachusetts, USA

Current techniques of myocardial perfusion quantification using MR require the measurement of the arterial input function or the concentration of the contrast media in the blood pool. However, the signal in the ventricular blood pool is not an accurate representation of the arterial input function. The proposed method seeks to maintain spatial coverage of the myocardium, while simultaneously allowing for the acquisition of a measurement slice that will provide a more accurate representation of the arterial input function.

**An Assessment of Free Breathing on Image Quality for Visual and Semi Quantitative Cardiac Perfusion**

Srirama V. Swaminathan¹, Christine M. Rattin², David Ian Paterson², Marcel Breuer³, Roquell Wyche², David Owen², Anthon R. Friac³  
¹Philips Medical Systems, Cleveland, Ohio, USA; ²Washington Hospital Center, Washington, District of Columbia, USA; ³Philips Medical Systems, Best, Netherlands

Free breathing (FB) cardiac MR 1st pass perfusion images were acquired under rest and stress using the vasodilative adenosine to assess CAD. It is found in literature that adenosine causes dyspnea and breath holding the patient during acquisition may not work well. The effect of FB on image quality was measured. Qualitative and quantitative perfusion data analysis was performed. Quantitative assessment was done using a semi-quantitative analysis tool. Results were compared with each other and also with cardiac catherization. It is found that FB does not affect the results significantly; the semi-quantitative tool robustly corrects for the translation and rotation.

**Improved Quantitative Cardiac Perfusion in High CA Dose MR First Pass: Patient Study**

Florian Fidler³, Alexandra Rauch³, Christian M. Wacker³, Wolfgang R. Bauer³, Axel Haase³, Peter M. Jakob³  
³University of Würzburg, Würzburg, Germany, Germany

A new model for quantitative evaluation of first pass perfusion experiment is proposed to calculate absolute contrast agent (CA) concentration from exponential approximation of measured signal. It depends on the knowledge of the baseline precontrast signal and the underlying tissue and blood pool T1. This model was tested in a patient study and extended simulations with encouraging results. The approach improves quantitative evaluation even in the high dose regime and therefore increases contrast to noise ratio (CNR), offering the opportunity to inject a 3-fold higher dosage.
Factors Affecting the Arterial Input Function in Myocardial Perfusion CMR

Peter D. Gatehouse, Andrew G. Elkington, Taigang He, Dudley J. Pennell, David N. Firmin
Imperial College of Science Technology and Medicine, London, UK

Greater understanding of the influences upon the arterial input function (AIF) would allow its optimisation for improved quantitative perfusion CMR. The aim of this study is to investigate potential influences upon the AIF, including injection speed, cardiac function and breath-hold. A multipoint saturation recovery FLASH technique was optimised for dynamic blood T1 measurement during first-pass. It was found that the T1 shortened as cardiac output increased, that the T1 at the peak concentration of the bolus in the ascending aorta shortened and that the duration of the arterial input function also shortened as the injection rate increased.

Manganese Infusion During Acute Ischemia Delineates Myocardial Area at Risk up to 2 Hours After Reperfusion

Anthony Homer Aletras, Alex Natanzon, Li-Yueh Hsu, Gauri Tilak, Andrew Ernest Arai
National Institutes of Health, Bethesda, Maryland, USA

Manganese infusion during acute ischemia marks the area at risk so that contrast enhanced CMR imaging performed 3.5 hours post-infusion (2 hours post-reperfusion) can delineate ischemic myocardium. This shows potential for use in a similar manner as nuclear medicine agents, which are injected during an acute episode and imaged later when the patient has stabilized.

3 Tesla MR Imaging Provides Improved Contrast in First-Pass Myocardial Perfusion Imaging Over a Range of Gadolinium Doses

Mayo Clinic, Rochester, Minnesota, USA; GE Medical Systems, Milwaukee, Wisconsin, USA

Imaging at 3T improves contrast in MR first-pass myocardial perfusion imaging, when using either 0.10 mmol/kg or 0.075 mmol/kg. Improved contrast during myocardial perfusion is an additional benefit to imaging at 3T in addition to previously demonstrated improvements in SNR and CNR.

Myocardial Perfusion Imaging with Arterial Spin Labeling Using Saturation-Prepared TrueFISP

Karaneh Razavi, Christian M. Wacker, Lothar R. Schad
Deutsches Krebsforschungszentrum (DKFZ), Heidelberg, Germany; University of Wuerzburg, Wuerzburg, Germany

Arterial spin labeling is a non-invasive technique used to measure the myocardial perfusion without applying contrast agent. This can be assessed by measuring the difference in the T1 between global and slice-selective spin preparation. To sample the T1-relaxation curve several images are acquired within a single breath-hold using a saturation recovery TurboFLASH pulse sequence. Due to the low signal-to-noise ratio the image quality is not sufficient for a precise T1 calculation. To achieve a higher image contrast and an improvement in image quality a saturation prepared TrueFISP combined with ASL is tested to study the changes in the myocardial perfusion.

Image Reconstruction Scheme for Dynamic Perfusion Myocardium MRI Study

Eugene G. Kholmovski, Prashanthi Venuri, Edward V.R. Di Bella
University of Utah, Salt Lake City, Utah, USA

Dynamic myocardial perfusion MRI studies are widely used to detect perfusion deficit of myocardium. Typically the image quality of these studies is acceptable for a qualitative analysis but not good enough for a quantitative analysis such as estimation of absolute myocardial blood flow, washin time characteristics. For reliable evaluation of these parameters, improvement of image SNR and elimination of possible sources of systematic errors such as a bias in magnitude reconstructed MRI images are required. To partially solve these problems in dynamic perfusion MRI studies a novel reconstruction method combined with anisotropic diffusion filtering in spatial-temporal domain has been developed.

Graphical Interpretation of Dynamic MR Perfusion Data

Tao Li, Garth M. Beach
University of Maryland Medical Center, Baltimore, Maryland, USA

Dependence of indices obtained graphically from the myocardial residue curve, on perfusion kinetics was investigated. Simulations were performed using the MMID4 model, combined with an input function derived from a clinical, peripheral bolus injection of Gd-DTPA. The initial upslope index is chiefly dependent on flow, but also depends on plasma volume. Indices obtained at peak enhancement had a complex dependence: The large effect-size of the delayed height parameter, and its single dependence on the volume of distribution, makes it a promising index.
Influence of the Fit-Function on Myocardial Perfusion Measurements

Andrea Karg¹, Katja Oberholzer¹, Nico Aabeguenevardene¹, Bernd Romamehse¹, Dietmar Becker¹, Markus Vosseler¹, Nico Hoffmann¹, Georg Horstick¹, Karl Friedrich Kreitner¹, Wolfgang Günther Schreiber¹
¹Johannes Gutenberg-University, Mainz, Rheinland-Pfalz, Germany

Influences on myocardial perfusion reserve (MPR) determination by a linear fit, a gamma-variate fit and numerical calculation of the steepest slope were examined. Variations between the linear and both other methods were large ((-4.5 ± 29.3)% for linear vs. gamma-variate and (-4.5 ± 28.9)% for linear vs. numerical evaluation). Variations between gamma-variate and numerical calculation were smaller (-0.01 ± 1.8%). If the fit range was expanded by two time-points, variations were largest for linear fit function ((0.41 ± 19.5)%) and smaller for the gamma-variate fit ((1.0 ± 12)%). The numerical calculation is not influenced by a change of the evaluation-range.

Performance of a Two Compartment Model Methodology for Myocardial Perfusion Imaging

Sathya Vijayakumar¹, Edward VR DiBella¹, Chris J. McGann¹, Jeffrey Dee Olpin¹, Henry Buswell¹
¹University of Utah, Salt Lake City, Utah, USA

The aim of this study was to assess the detection of coronary artery disease (CAD) using a two-compartment model analysis of images obtained at rest and under adenosine-induced vasodilation. It involved estimating the tissue contrast washin parameter by fitting the tissue uptake curves to a two-compartment model with the fraction of blood in a given tissue region and time delay parameters also being fit. Its performance was compared to the simpler upslopes method, scoring by blinded readers and the patients’ coronary angiography reports. The results show that this method may be more optimal for the detection of CAD.

Dynamic Measurement of Blood T₁ for Perfusion Cardiovascular Magnetic Resonance

Taigang He¹, Peter D. Gatehouse¹, Andrew G. Elkington¹, Dudley J. Pennell¹, David N. Firmin¹
¹Imperial College of Science Technology and Medicine, London, UK

The purpose of this study is to optimize a multipoint saturation recovery (SR) FLASH technique for dynamic first-pass measurement. This technique uses a very low flip angle and non-selective saturation to minimize fresh inflow effects. The short low resolution sequence and a centric-out phase-encoding order enabled acquisition with short SR delays. Multiple SR images can be obtained during each cardiac cycle to give an accurate estimation of rapidly changing T₁ values during peak gadolinium concentration. This technique has been validated on phantoms and employed to investigate effects of injection rate and cardiac function upon the arterial input function in patients.

Partial Fourier Steady-State Free Precession (FIESTA) First-pass Perfusion with Improved Image Quality and Efficient Spatial Coverage

Thomas K.F. Foo¹, Katherine C. Wu², Clerio F. Azevedo², Vincent B. Ho³, David A. Bluemke², Dara L. Kraitchman³
¹GE Medical Systems, Baltimore, Maryland, USA; ²Johns Hopkins University, Baltimore, Maryland, USA; ³Uniformed University of the Health Sciences, Bethesda, Maryland, USA

A method using steady-state free precession to visualize the first pass perfusion is described. Using partial Fourier reconstruction, 6-10 slice locations can be imaged every 2 RR intervals with high spatial resolution. The proposed technique was compared to a standard interleaved EPI gradient echo (FGRET) acquisition and was found to have improved contrast enhancement ratios (CER) at the same contrast media dose. Acquisition time per image was 205 ms compared to 168 ms for FGRET, yielding comparable (high) efficiency in spatial coverage per unit time.

Flow Quantification

Room J Wednesday 13:30 - 15:30

Quantitative In Vivo Characterisation of Aortic Banding in the Mouse using High-Resolution MRI

Jürgen E. Schneider¹, Craig A. Lygate¹, Karen Hulbert¹, Paul J. Cassidy¹, Kieran Clarke¹, Stefan Neubauer²
¹Oxford University, Oxford, Oxon, UK

Transverse aortic constriction (TAC) in the mouse is a commonly used surgical model of cardiac hypertrophy and subsequent failure. However, there is considerable variability in the extent of hypertrophy. To determine whether variability in the constriction might account for this, we developed a non-invasive MRI technique to allow 3D visualization of the stenotic aorta and measurement of its minimal cross-sectional area.

Blood Velocity Imaging using Spiral Phase Contrast with Complex Difference Processing

Reza Nezafat¹, Richard B. Thompson¹, Elliot R. McVeigh¹
¹National Institutes of Health, Bethesda, Maryland, USA

We measured through-plane blood velocity in the ascending aorta with spiral phase contrast processed using complex difference methods. The relatively long TRs required to minimize the saturation of blood-pool spins in complex difference processing provide sufficient time for acquisition of spiral interleaves. Complex difference processing of phase contrast data subtracts out the signals from stationary tissue which both eliminates partial volume effects and allows for a drastic reduction of FOV. Blood velocities measured with complex difference and phase difference methods are compared for both full FOV and reduced FOV cases.
13:32  **1852. Automated Phase Correction for Quantitative Phase-Contrast Flow Measurements**

*Jason Andrew Polzin*, Yong Zhou

1GE Medical Systems, Waukesha, Wisconsin, USA

Flow quantification using phase-contrast is affected by non-zero background phase induced primarily by eddy current differences between the flow-encoded acquisitions. A global phase correction can be applied but is perturbed by flow-induced phase and may introduce additional errors. An automated method for correcting phase-contrast images for residual background phase that is independent of flow-induced phase is introduced. This method uses the inherent pulsatility of blood to create a mask for the phase correction that only includes the background signal. This technique is shown to compare favorably to a phantom based phase correction measured from identical scan parameters.

13:33  **1853. Analysis and Correction of Gradient Nonlinearity and B₀ Inhomogeneity Scaling Errors in 2DPC Flow Measurements**

*Johannes Martinus Peeters*, Clemens Bos, Chris J G Bakker

1University Medical Center, Utrecht, Netherlands

Gradient nonlinearity and field inhomogeneity scale the result of phase contrast flow measurements in two ways: incorrect velocity-encoding of moving spins and geometric distortion of the vessel cross-sectional area. A flow phantom, consisting of a 3D grid of interconnected tubes, was used to determine the spatial dependence of the associated scaling factors. Next, these factors were used for correction of flow measurements. The relevance of this exercise was demonstrated for a clinical application, viz. flow measurements in the loop graft of hemodialysis patients, in which the off-center forearm position is a trade-off between patient comfort and local measurement accuracy.

13:34  **1854. Four-Dimensional Magnetic Resonance Velocity Mapping: Velocity Profile of Blood-Flow through the Thoracic Aorta in 10 Healthy Volunteers**

*Michael Hope*, Jonathan Levin, Michael Markl, Mary Draney, Nathan Wilson, Robert Herfkens

1Stanford University, Palo Alto, California, USA

4D MR velocity mapping is a new technique for evaluation of multidirectional blood flow. This study utilizes 4D volumetric datasets to evaluate the velocity distribution of normal blood flow in cross-sectional planes along the thoracic aorta for 10 healthy subjects. Corrected velocity data are then imported into a visualization software package allowing for interactive navigation of data throughout all time frames. This study provides quantitative analysis of blood flow velocities in 2D cutplanes that are placed at any spatial and temporal location within the data set. This is a clear advantage compared to traditional 2D phase contrast MR imaging technique.

13:35  **1855. Correlation Analysis of Stenotic Aortic Valve Flow Patterns using Phase Contrast MRI**

*Emily A. Waters*, Shelton D. Caruthers, Samuel A. Wickline

1Barnes-Jewish Hospital at Washington University School of Medicine, St. Louis, Missouri, USA

We investigated the theoretical robustness of an automated data collection methodology for evaluating aortic stenosis. MRI flow images were acquired in 22 patients, in image planes located 1.0cm and 1.5cm distal to the aortic valve plane. Regions of interest drawn about the aortic lumens were cross-correlated to evaluate the similarity of flow profiles at the two levels. Flows correlated well, with (0,0) correlation offsets for 17 of 22 patients and average maximum correlation values of 0.88±0.11. The similarity of flow patterns indicates that an automated algorithm would be relatively insensitive to distance above valve plane in the range of 1.0-1.5cm.

13:36  **1856. Quantification of Aortic Insufficiency: Comparison Between Phase Contrast and Volumetric Techniques**

*Bhavani Balaravi*, James F. Glockner, Donald L. Johnston

1Mayo Clinic, Rochester, Minnesota, USA

Quantification of aortic insufficiency can be performed using cine phase contrast velocity mapping in the proximal aorta. An alternative technique involves volumetric determination of RV and LV stroke volumes from short axis cine images. Both techniques generally provide accurate measurement of regurgitant volumes.


*Robert Merrifield*, Quan Long, Yun Xu, Guang-Zhong Yang

1Imperial College, London, UK

The relationship between the morphology and blood flow of the left ventricle during myocardial remodeling is complex and not yet fully understood. Detailed understanding of this relationship can be enhanced by the combined use of Computational Fluid Dynamics and Cardiovascular MR. One of the key drawbacks of ventricular flow simulation is that it is sensitive to the prescribed inflow boundary conditions. Currently, the extent to which this affects in vivo flow simulation is unknown. In this work, we measure this sensitivity as a function of the inflow direction and determine the limit that is required for accurate ventricular flow simulation.
13:38  **1858. Eight-fold Acceleration of PC-SSFP Velocity Mapping using k-t BLAST**  
Christof Baltes1, Sebastian Kozerke1, Jeffrey Tsao1, Klaas P. Pruessmann1, Peter Boesiger1  
1University and ETH, Zurich, Switzerland

In this work, we accelerated steady-state-free-precession-based phase-contrast velocity mapping (PC-SSFP) using k-t BLAST. The PC-SSFP method provides phase images with high signal-to-noise ratio throughout the cardiac cycle, while k-t BLAST allows for up to 8-fold acceleration of data acquisition. Velocity data acquired with k-t BLAST were compared to standard PC-SSFP and PC-TFE velocity mapping in the ascending aorta of healthy volunteers. Good agreement was found among flow profiles from PC-TFE and PC-SSFP with and without k-t BLAST acceleration. In conclusion, PC-SSFP using k-t BLAST allows for accurate, high-resolution flow quantification in a single breath-hold.

Reza Nezafat1, Peter Kellman1, J. Andrew Derbyshire1, Elliot R. McVeigh1  
1National Institutes of Health, Bethesda, Maryland, USA

Imaging of the blood flow is investigated using spiral phase contrast with self-calibrated sensitivity encoding reconstruction. Spiral sampling of k-space has good motion and flow properties and efficient k-space coverage. Using SENSE, one can reduce the acquisition time or increase the spatial resolution. Here, a self-calibrated sensitivity encoding reconstruction for spiral sampling is introduced for measuring the blood flow in vessels. Undersampling up-to rate 4 is studied which results in decreasing the image acquisition time and breath-hold duration significantly while keeping spatial and temporal resolution constant.

13:40  **1860. 7D Flow through LVOT and Aortic Valve Utilising k-t Speed-Up Acquisition: Initial Work**  
Rado Andriantsimitia1, Christof Baltes1, Sebastian Kozerke1, Vivek Muthurangu1, Derek Hill1, Reza Razavi1  
1King's College of London, London, UK; 2ETH, Zurich, Switzerland

Flow quantification around pulmonary or aortic valve is important for management of cardiac disease. Velocity-encoding phase-contrast magnetic resonance magnetic imaging (PC-MRI) has largely been validated for quantitative estimation of blood flow. In clinical context, PC-MRI is time-consuming and the estimation in (through) a plane makes it difficult to track and analyse velocities over time. K-t acquisition is a new technique that considerably speeds up dynamic imaging. Applied on PC imaging, 3D volume, 3 directional velocities over time can be acquired rapidly. Used on a feasibility study, we demonstrate its potential for flow pattern analysis and quantification.

13:41  **1861. Quantitative Assessment of Coarctation Repair**  
Oliver M. Weber1, Sandra Pujadas1, Gautham P. Reddy1, Christopher Tan1, Phillip Moore1, Charles B. Higgins1  
1University of California, San Francisco, San Francisco, California, USA

Aortic coarctation is a congenital malformation of the aortic arch, restricting flow in the descending aorta. Quantitative flow measurements by means of MRI have been shown to reliably determine collateral flow and thus hemodynamic significance of the coarctation. We assessed aortic collateral flow prior to and after stent deployment in seven patients. A significant reduction in collateral flow was found in all patients within 24 hours after intervention. It is concluded that MRI can reliably assess the success of the stenting procedure.

13:42  **1862. Estimation of Pulmonary Windkessel Volume in Patients with Pulmonary Hypertension Using MR Phase Contrast Imaging**  
Hsu-Hsia Peng1, Hsi-Yu Yu1, Hsiao-Wen Chung, Wen-Yih Isaac Tseng  
1National Taiwan University, Taipei, Taiwan; 2National Taiwan University Hospital, Taipei, Taiwan

It has been demonstrated in previous studies that the windkessel volume (Vwk) and its derivative hemodynamic parameters are correlated with the properties of the aorta. However, the role of Vwk in pulmonary circulation is largely unknown. In this study, we use MR phase contrast imaging to estimate the values of Vwk in pulmonary circulation. Experimental results show that Vwk for patients with pulmonary hypertension were significantly higher than healthy volunteers at the p < 0.001 level.

13:43  **1863. Angularly Undersampled PR-TRICKS for the Determination of Pulmonary Transit Time**  
Ty A. Cashen1, James C. Carr1, Andrew C. Larson1, Randall Kroeker1, Timothy J. Carroll2  
1Northwestern University, Chicago, Illinois, USA; 2Siemens Medical Solutions, Chicago, Illinois, USA

Angularly undersampled projection-reconstruction imaging has been shown to allow for high quality 3D time-resolved contrast-enhanced MR angiography, especially when combined with the TRICKS segmentation scheme. We have employed this pulse sequence to capture the dynamic passage of contrast through the pulmonary vasculature for the determination of pulmonary transit time. 3D volumes were acquired at a temporal resolution of 1.3 s/frame. Noninvasive assessment of pulmonary transit time could potentially be used to diagnose and monitor patients with cardiopulmonary disorders such as congestive heart failure.
13:44 1864. Pulmonary Vein Flow to Determine Left Atrial Pressure: Can MRI Phase Velocity Mapping Compete with Echocardiography?
Veronica Lenge1, Raja Muthupillai2, Mercedes Pereyra1, Eric Douglas1, Antonietta Hernandez1, Juan Carlos Rozo1, Raymond Stainback1, Scott D. Flamm1
1St. Luke's Episcopal Hospital, Houston, Texas, USA; 2Baylor College of Medicine, Houston, Texas, USA

In this prospective study we present the results of pulmonary venous flow (PVF) in 17 patients studied using MR phase velocity mapping and Doppler echocardiography. Blood flow pattern was described using conventional metrics systolic (S) and diastolic (D) peak velocities, S/D ratio, atrial reversal peak velocity (Ar) and atrial reversal duration (Adur) to assess left atrial pressure and compare the MR flow pattern with Doppler Echocardiography.

Anthony Z. Faranesh1, Diana Lancaster2, Gina Orcino2, Joni Taylor2, John Bacher2, Dara L. Kraitchman1, Elliot R. McVeigh2
1The Johns Hopkins University, Baltimore, Maryland, USA; 2National Institutes of Health, Bethesda, Maryland, USA

Blood volume (BV) and permeability surface product (PS) are useful physiologic parameters to characterize tissue microvasculature. These parameters were measured in rabbit skeletal muscle using a multislice fast T1 mapping method coupled with the administration of the macromolecular contrast agent Gadomer-17. In normal muscle significant differences in BV were observed between slow-twitch and fast-twitch muscles. The method was also used to measure BV and PS under ischemic conditions, and large regional variations were observed.

13:46 1866. Skeletal Perfusion Measurements during Graded Exercise in Rat Hind Limb
Kenneth I. Marro1, Outi M. Hyyti1
1University of Washington, Seattle, Washington, USA

The goal of this study was to develop a technique to measure skeletal muscle perfusion dynamics during graded exercise. Single voxel perfusion measurements were acquired at different metabolic loads by varying the force of stimulated contractions in rat hind limb. The results show a significant difference in the amplitude of the perfusion response. In addition the time course of perfusion changes during stimulation and recovery can be easily determined.

Oliver Wieben1, Stephan H. Schirmer1, Bernd A. Jung1, Eva E. Buschmann1, Ivo R. Buschmann1, Jurgen Hennig1
1University Hospital Freiburg,

A fast MR phase contrast (PC) cine imaging protocol for the evaluation of peripheral arterial obstructive disease during post-ischemic reactive hyperemia was implemented and evaluated. The mean arterial blood flow in the iliac artery was measured with a segmented k-space acquisition before, during, and after inflation of a thigh cuff to suprasystolic pressures. The flow reserve after one minute occlusion was found to be significantly lower in patients with disease (44.2%±24.3%) as compared with healthy volunteers (126.8%±49.7%). A potential use of this technique is the non-invasive evaluation of arteriogenesis therapy for the stimulation of collateral artery growth.

13:48 1868. Assessment of the Rupture Risk of Abdominal Aortic Aneurysms by Patient-Specific Hemodynamic Modeling - Initial Results
Marcel Breeuwer1, Ursula Götte1, Kees Visser1, Romhild Hoogeveen1, Franck Laffargue2, Jean-Michel Rouet2, Berent Wolters3, Sander de Putter3
1Philips Medical Systems, Best, Netherlands; 2Philips Research France, Suresnes, France; 3Eindhoven University of Technology, Eindhoven, Netherlands

At present, the diameter of an abdominal aortic aneurysm (AAA) is considered to be the primary indicator of rupture risk. Surgical treatment is usually performed if the diameter exceeds 5 cm. Rupture does however occur for diameters less than 5 cm. We have therefore started to investigate if better rupture risk indicators can be obtained by patient-specific hemodynamic modeling. This paper discusses the steps involved in this modeling and it describes our approach and first results for each of the steps.

13:49 1869. Effects of Very Low Spatial Resolution on Quantitative Phase-Contrast Flow MRI Measurements
Kerstin Magdalena Lagerstrand1, Barbro Vikhoff-Baaz2, Goran Starck1, Sven Ekhollm1, Eva Forsell-Aronsson1
1Göteborg University, Sahlgrenska University Hospital, Göteborg, Sweden

Quantitative flow measurements using phase-contrast MRI suffers from the effect of limited sampling. Simulations are presented that show the effect on the estimates of velocity and flow rate at different contrasts. The estimated velocity decreases and the estimated flow rate increases as the spatial resolution decreases. When a background signal is present, the estimated flow rate reaches a maximum before it decreases and approaches zero. For full background suppression, however, the estimate at zero spatial resolution is a measure of the mean velocity in the vessel. Thus, in principle, accurate flow quantification is possible even at zero spatial resolution.
13:50  1870. Coherent Steady State Flow Quantification at 1.5 and 3 Tesla
John W. Grinstead1, Shantanu Sinha1, Yih-Lin Nien1, Satoshi Tateishi1, Fernando Vinuela1
1University of California, Los Angeles, Los Angeles, California, USA

Recently, a fast, high-SNR method for thru-plane phase-contrast flow quantification based on balanced steady state free precession imaging, termed PC-SSFP, was developed. The present work applies this technique to human and animal carotids at 1.5 and 3T, and evaluates the feasibility of extending the scheme for in-plane flow encoding.

Mario Forjaz Secca1, Augusto Goulao2, Julia Duarte3, Pedro Vilela2
1Univ. Nova de Lisboa, Monte de Caparica, Portugal; 2Hosp. Garcia D'Orta, Almada, Portugal; 3Ressonancia Magnetica - Caselas, Lisboa, Portugal

Different studies on the quantification of CSF flow at the level of the Aqueduct suggest different quantities to assess abnormality of flow: Stroke Volume and Flow Rate. In this study we compared the results of these two quantities for over 200 patients and considered physiological data to conclude that the Flow Rate should be a better parameter to assess abnormality. We also obtained some correlation between these parameters and the cross sectional area of the Aqueduct.

13:52  1872. MRI Velocity Data Reconstruction for Power Loss Estimation
David Harold Frakes1, Hiroumi Kitajima1, Mark JT Smith2, Ajit P. Yoganathan1
1Georgia Institute of Technology, Atlanta, Georgia, USA; 2Purdue University, West Lafayette, Indiana, USA

Quantification of the power dissipated as blood circulates offers valuable insight into the efficiency of vascular structures. At present methods are not established for estimating power loss in vivo. Here a novel technique is proposed for the reconstruction of three-dimensional flow fields from MRI velocity data. Adaptive control grid interpolation is employed to facilitate reconstruction and reconstructed data sets are used to estimate power losses in vascular structures via the viscous dissipation function. This methodology ultimately provides a framework for evaluating the results of cardiovascular surgeries and is aimed at identifying optimal surgical designs.

Coronary MR Imaging

Room J    Thursday 13:30 - 15:30

13:30  1873. Coronary Artery Wall Imaging at 3 Tesla: A Feasibility Study
Ioannis Koktzoglou1, Orlando Simonetti2, Debiao Li1
1Northwestern University, Evanston, Illinois, USA; 2Siemens Medical Solutions, Chicago, Illinois, USA

A major problem in coronary artery wall imaging at 1.5T is low signal-to-noise ratio (SNR). 3T whole body imaging systems may improve SNR. Potential problems for 3T turbo spin echo (TSE) coronary wall imaging include B1 inhomogeneity, amplified ECG artifacts, and high specific absorption rates (SAR). The goal of the study was to evaluate the feasibility of 3T coronary wall imaging despite these potential problems.

13:31  1874. Preliminary Results in Coronary MRA at 3 Tesla using TFE and Balanced-TFE Sequences
Michael Gerhard Kaul1, Alexander Stork1, Peter Martin Bansmann1, Gunnar Konrad Lund1, Christoph Weber2, Kay Nehrke2, Gerhard Adam2
1University Hospital Hamburg-Eppendorf, Hamburg, Germany; 2Philips Research Laboratories, Hamburg, Germany

Current limitations in coronary magnetic resonance angiography (MRA) are spatial resolution and respiratory motion artefacts. High-field systems provide a higher signal-to-noise ratio (SNR) but also unfavourable side effects. The aim was to test the feasibility of coronary angiography on a clinical 3T system using T2 prepared turbo field echo (TFE) and balanced-TFE (TrueFISP, FIESTA) sequences. The results show higher CNR and larger visualized vessel length for T2 prepared TFE than for balanced-TFE sequences. B-TFE suffers from off-resonance effects which makes excellent shimming necessary.

Xiaoming Bi1, Brian Schirf1, Debiao Li1
1Northwestern University, Chicago, Illinois, USA

Administration of T1 shorting agent has been successfully applied at 1.5T to increase the SNR and CNR. At 3.0T, tissue T1 is prolonged and T1 relaxivity of the contrast agent may change as well. This study evaluated the feasibility and performance of a contrast-enhanced coronary MRA at 3.0T using a three-dimensional, breath-hold, segmented FLASH sequence. Measured results showed a 53% increment in SNR and a 305% enhancement in CNR in contrast agent first pass images. Compared to a previous 1.5T study using similar imaging protocol, the SNR, CNR, spatial resolution and vessel sharpness were all increased.
This study focuses on the examination of ECG gated 3D FIESTA in conjunction with sensitivity encoded parallel imaging for breath-held coronary artery MR angiography at 3 very high filed strengths. We demonstrate that robust breath-held CMRA at 3 Tesla can be completed in 2-3 breath-holds covering the main branches of the coronary arterial systems. Our initial experience suggests that the SNR improvement afforded by a 3 Tesla field strength coupled with the enhanced CNR between the blood pool and the myocardium may provide benefits for clinical coronary MR angiography.

Real time MR coronary angiography(RT MRCA) remains challenging. RT MRCA may benefit from higher SNR at 3T; however, increased susceptibility induced off resonance and RF homogeneity must be managed. A spectral spatial RF pulse with a sharp profile was designed to address these challenges. Fourteen subjects underwent RT MRCA at 3T. Scan time was less than 20 minutes. Good image quality and wide anatomic coverage was achieved. Future studies are needed to determine the clinical utility of RT MRCA at 3T.

The aim of this study was the investigation of the impact of radial k-space sampling for steady-state free precession (SSFP) spin labeling coronary MR-angiography. In 12 healthy adult volunteers identical coronary SSFP spin labeling imaging sequences were performed using standard cartesian as well as radial k-space sampling. Contrast-to-noise ratio, vessel sharpness and motion artifact level were compared. Radial scanning showed significantly higher CNR and vessel sharpness as well as a lower motion artifact level. In conclusion, radial SSFP imaging is a new promising technique for spin labeling coronary MR-angiography.

Volumetric breath-held coronary MRA was implemented using a 3D SSFP sequence in conjunction with sensitivity encoded parallel imaging, which permits to image the major coronary artery distributions in 2-3 breathholds. Two acquisition strategies (1 R-R and 2 R-R interval approach) were developed to achieve very short and clinically acceptable breathhold times and to limit the acquisition to mid-diastole while remaining a 1 mm in-plane spatial resolution. The decimation in the number of phase encoding steps reduced the sensitivity to cardiac and respiratory motion, which resulted in substantial improvements in the delineation of the coronary arteries, especially for the distal segments.

High-resolution SENSE coronary MRA requires highly accurate coil sensitivity to avoid residual aliasing artifacts and amplified noises in a reconstructed image. The most common way of calibrating the coil sensitivity is to acquire a separate low-resolution image. However, it may result in significant calibration errors, since coil and cardiac position are not exactly identical during sensitivity measurement and actual accelerated acquisition. In this work, we propose a robust method of the coil sensitivity calibration incorporated with actual accelerated data acquisition in a single measurement by extending data acquisition window in a cardiac diastolic phase and reordering phase encoding gradients.

Whole-heart coronary MRA has been shown to provide better visualization of the coronary vessels than targeted approaches. Using 2D-SENSE with a total acceleration factor of 4, imaging time has been reduced from approximately 12 minutes to approximately 6 minutes, rivaling acquisition times of conventional volumes that target only a single vessel. It is shown that higher SENSE factors lead to only minor loss in image quality.
13:39 1882. Adaptation of Coronary Imaging Pulse Sequences for Self-Calibrated Non-Cartesian Parallel Imaging
Ernest Yeh¹, Rene Botnar², Tim Leiner³, Charles McKenzie², Daniel Sodickson⁴
¹Harvard-MIT, Boston, Massachusetts, USA; ²Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; ³Maastricht University Hospital, Maastricht, Netherlands

Speed and timing are crucial considerations for coronary magnetic resonance angiography (MRA). Parallel imaging has been applied in coronary MRA to achieve accelerations in overall scan time. Moreover, parallel imaging yields new possibilities such as image quality improvement from overcoming some of the coronary MRA timing constraints. In this work, two 3-D (spiral and radial) sequences were tested. The normal acquisition window was shortened by various factors, reducing the number of readouts per RR interval. The would-be longer scans were accelerated via self-calibrating parallel imaging to revert to the original scan time. Images acquired under different timing constraints were compared.

13:40 1883. High Resolution True-FISP Coronary MRA with Self-Calibrating Partially Parallel Acquisition
Jaeseok Park¹, Debiao Li¹
¹Northwestern University, Chicago, Illinois, USA

Coronary MRA requires high spatial resolution due to the small size of arteries. However, high-resolution breath-hold coronary MRA has not been amenable by a limited imaging time. A k-space based partially parallel imaging technique, GRAPPA, was recently introduced to reduce the imaging time. In this work, instead of releasing the constraint of the imaging time, GRAPPA with accelerated sampling is used to increase the spatial resolution under the same imaging time as root sum of squares reconstruction (no GRAPPA) with conventional sampling. Two images reconstructed with and without GRAPPA are analyzed qualitatively and quantitatively.

13:41 1884. Preliminary Results of a Novel Prospective Respiratory Motion Correction Approach for Free-Breathing Coronary MR Angiography using a Patient-Adapted Affine Motion Model.
Michael Gerhard Kaul¹, Kay Nehrke¹, Alexander Stork¹, Paul Martin Bansmann², Gunnar Konrad Lund², Christoph Weber¹, Gerhard Adam¹
¹University Hospital Hamburg-Eppendorf, Hamburg, Germany; ²Philips Research Laboratories, Hamburg, Germany

Current limitations in coronary magnetic resonance angiography (MRA) are spatial resolution and respiratory motion artefacts. Free-breathing coronary MRA using a patient-specific adaptive model helps to overcome respiratory motion artefacts also at 20mm gating window, reducing scan time in comparison to the standard slice tracking approach with 5mm gating window.

13:42 1885. Prediction of Heart Rate Variation during Coronary MRA, using a Neuronal Network
Martin Buehrer¹, Michael E. Huber¹, Sebastian Kzerke¹, Peter Boesiger¹
¹University and ETH Zuerich, Zuerich, Switzerland

In electrocardiographically triggered coronary MRA, data acquisition is limited to a short cardiac rest period during mid-diastole. Therefore, prior to the scan, a heart rate dependent trigger delay has to be set, which defines the time delay between the R-wave detection and the data acquisition. Since the heart rate and its related optimal trigger delay can vary considerably during the scan, a neural network was developed, which predicts changes of the heart rate and prospectively adapts the trigger delay for each cardiac cycle. Simulations and first in-vivo measurements demonstrated that the approach enabled an accurate prediction of heart rate variations.

13:43 1886. Onset of the Diastolic Cardiac Rest Period: Intra-Volunteer Variability
Detlef Mentrup¹, Kay Nehrke¹, Peter Börnert¹
¹Philips Research Laboratories, Hamburg, Germany

This study investigates onset and duration of the diastolic cardiac rest period for 10 volunteers both at rest and at increased heart rates. For this purpose, the correlation of successive images in a cardiac cine scan has been analyzed. The measurements show that a shortening of the RR-interval mainly truncates the diastolic rest period (70% of total shortening), while the systole is shortened by 30%. This result supports the idea of a dynamic adaptation of the ECG-trigger delay in long cardiac MRA scans to avoid a mixing of different motion phases during image data acquisition.

13:44 1887. Quantification of Coronary Artery Motion using Cardiac Fat Navigator Echo
Thanh D. Nguyen¹, Yi Wang¹
¹University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

The recently developed cardiac fat navigator allows direct measurement of cardiac motion. This technique is employed here to quantify the motion of coronary arteries in humans and correlate motion measurement with the electrocardiogram.
13:45 **1888**. **Translational Motion Correction Nearly Doubles the Rest Period of the Coronary Arteries During Tidal Breathing**  
Guy Shechter¹, Jon R. Resar¹, Elliot R. McVeigh²  
¹Johns Hopkins University, Baltimore, Maryland, USA; ²National Institutes of Health, Bethesda, Maryland, USA  

Spontaneous tidal respiratory motion of the coronary arteries was studied. The duration of the quiescent phase at end-expiration was quantified. The effect of translation motion correction on the duration of the rest period was explored.

13:46 **1889**. **Free Breathing Interactive Coronary MRA Using Fat Suppressed 2D FIESTA**  
Wei Sun¹, Guang Cao¹, Thomas K. Foo¹, Liuquan Cheng¹, Youquan Cai¹  
¹GE Medical Systems China, Beijing, People's Republic of China; ²GE Medical Systems, Baltimore, Maryland, USA; ³PLA General Hospital, Beijing, People's Republic of China  

An interactive free breathing coronary MRA technique was developed using ECG gated fat suppressed 2D FIESTA. A 2D coronary image can be acquired in a single or double RR interval and arbitrary imaging plane can be interactively localized. The initial result indicates that single RR interval acquisition works better on subjects with slow heart rate (<62 bpm), however, for subjects with fast heart rate (>62 bpm), double RR interval should be used to reduce the cardiac motion artifacts.

13:47 **1890**. **Modelling the Cardiac Electromechanical Activity for Integration of Electrophysiological Studies with MR**  
Maxime Sermesant¹, Kawal S. Rhode¹, Sanjeeet Hedge¹, Gerardo I. Sanchez-Ortiz², Daniel Rueckert², Pier Lambiase³, Clifford A. Bucknell³, Derek L. G. Hill³, Reza Razavi¹  
¹King's College London, London, UK; ²Imperial College London, London, UK; ³St Thomas’ Hospital, London, UK  

We present a combination of new electrophysiological mapping systems with XMR guided electrophysiology studies (EPS) procedures. Cardiac MR imaging offers precise anatomical and functional information prior to and after the procedure, as well as help the guidance during intervention. In the current work we apply our registration technique between X-ray and MR to EPS procedures with the aim to validate our electromechanical model of the heart. Such models offer an integration tool including anatomical, mechanical and electrophysiological information in the same framework. And it makes possible the simulation of pathologies, as well as intervention planning.

13:48 **1891**. **Volumetric Coronary MRA: Visualization of Coronary Arteries and Veins Using Ray Casting and the Bubble Wave Algorithm**  
Harvey E. Cline¹, Thoralf Niendorf¹, Neil Rosky¹  
¹General Electric, Niskayuna, New York, USA; ²General Electric, Waukesha, Wisconsin, USA; ³Harvard Medical School, Boston, Massachusetts, USA  

A 3D FIESTA cardiac acquisition covering a 6cm slab in a single breath hold was volume rendered by casting rays onto a surface shell and projecting both the coronary arteries and veins. The blood pool was selectively removed using the bubble wave algorithm. Surfaces of the proximal RCA and LAD with coronary veins are well contoured by the maximum intensity projection through a 5mm thick region of the surface.

13:49 **1892**. **Interleaved Spiral Phase Velocity Mapping of Left and Right Coronary Artery Blood Flow: Correction for Through-Plane Motion using Selective Fat-Only Excitation**  
Jennifer Keegan¹, Peter Gatehouse¹, Guang-Zhong Yang², David Firmin¹  
¹Royal Brompton Hospital, London, UK; ²Imperial College of Science, Technology and Medicine, London, UK  

We have developed a method of correcting right and left coronary flow velocities for through-plane motion of the vessel. It uses selective velocity mapping of fat surrounding the artery, either in a separate acquisition or interleaved with the water-excitation acquisition used to determine flow velocity. Both methods have been successfully implemented in 10 right and 6 left arteries, with no significant differences found between them when comparing mean systolic and mean diastolic velocities. As in Doppler studies, the corrected left coronary profiles are diastolic predominant whereas the right profiles are biphasic, with approximately equal flow in systole and diastole.

13:50 **1893**. **Coronary Magnetic Resonance Angiography – Comparisons between Gd-DTPA and Gd-BOPTA Enhanced FLASH Sequence and Non-Contrast Enhanced SSFP Sequence**  
Thomas Schlösser¹, Sandra Massing¹, Peter Hunold¹, Christoph U. Herborn¹, Florian Vogl¹, Kai-Uwe Waltering¹, Jörg Barkhausen¹  
¹University Hospital Essen, Essen, NRW, Germany  

The aim of this study was to compare contrast enhanced CMRA using a gradient-echo fast low-angle shot (FLASH) sequence with a non-contrast enhanced steady state free precession (SSFP) sequence. CMRA was performed twice in 5 healthy volunteers using either Gd-DTPA or Gd-BOPTA in randomized order. Over the duration of 30 min the CNR in the Gd-BOPTA data sets (18.8 ± 1.6) was significantly higher compared to the Gd-DTPA images (11.3 ± 1.4; p<0.05). CNR in the SSFP data sets (14.3 ± 6.4) was not significantly different to Gd-DTPA (p = 0.17) and Gd-BOPTA images (p = 0.05).
13:51 1894. Quantification of Vulnerability of Coronary Artery Plaques with MRI and Biomechanics: An Ex Vivo Study

Jie Zheng, Dalin Tang, Faith E. Rowold, Tom Pilgram, Jeffrey E. Saffitz, Pamela K. Woodard
1Washington University School of Medicine, St. Louis, Missouri, USA; 2Worcester Polytechnic Institute, Worcester, Massachusetts, USA; 3Washington University, St. Louis, Missouri, USA

The aim of this study was to quantitatively evaluate the relationships among plaque vulnerability and characteristics of MR contrasts, plaque morphology, and stress/stRAIN. 11 coronary artery plaque specimens were obtained from 5 autopsy cases and T1-, T2-weighted high resolution images were acquired and classified based on pathological findings. Vulnerable plaques are found to be strongly associated with large lipid pools and certain critical stress/stRAIN conditions. These findings provide an impetus to perform further research on a larger population of samples to define effective quantitative biomarkers to non-invasively assess the vulnerability of atherosclerotic plaque in vivo.

13:52 1895. Fat-Suppressed Cine SSFP Coronary Angiography

Peng Hu, Craig H. Meyer
1University of Virginia, Charlottesville, Virginia, USA

In this work, we combine cine SSFP sequence with the FEMR fat suppression to achieve high SNR, high temporal and spatial resolution and high contrast coronary artery images with fat suppression.

13:53 1896. Improved Fat Suppression for Coronary MR Angiography with Radial Balanced 3D SSFP through Interleaved Weighted Projection Sets

Dana C. Peters, Rene M. Botnar, Kraig V. Kissinger, Holger Eggers, Warren J. Manning
1Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; 2Philips Research, Hamburg, Germany

Robust and effective fat saturation is crucial for coronary MRA. A method for improving fat saturation in radially acquired 3D SSFP coronary MRA was investigated. Projections were collected in two interleaved sets, one of which was collected soon after the fat saturation pulse. This set of data was used for the central k-space, while both interleaves were used for outer k-space. The results showed improved effectiveness of the fat saturation pulse for the radial acquisition.

13:54 1897. Efficiency on Coronary Stenosis Evaluation Using Breath-hold Three-Dimensional FIESTA Sequence

Liuquan Cheng, Yuangui Gao, Wei Sun, Fugeng Sheng, Youquan Cai, Thomas K. Foo
1Chinese PLA General Hospital, Beijing, People's Republic of China; 2GE Medical System (China), Beijing, People's Republic of China; 3GE Medical System, Baltimore, Maryland, USA

To investigate the efficiency of breath-hold three-dimensional FIESTA (Fast Imaging Employing Steady State Acquisition) sequence, stenosis on coronary MRA and catheter angiogram was graded and compared segments by segments. The results revealed high accurate prediction on normal vessels and excellent sensitivity (94.0%) and specificity (95.7%) on hemo-dynamic significant stenosis graded over 50% but poor for more detail grading. Narrowed lumen, thicken wall, hemo-dynamic dilation and peri-focal infiltration were the primary indications for stenosis graded over 50%. Coronary MRA graded stenosis qualitatively rather than quantitatively but it was helpful for coronary artery disease screening.


Susan Bok Yeon, Rene M. Botnar, Kraig V. Kissinger, Pierre Voisine, Audrey Rosinberg, Roger J. Laham, Warren J. Manning
1Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

This study assessed the utility of coronary magnetic resonance angiography (MRA) to noninvasively characterize ameroid constrictor position on the left circumflex artery (LCX) and to assess coronary artery patency in a swine model of chronic myocardial ischemia. Findings from 3D SSFP coronary MRA images were compared with those from the same day x-ray coronary angiogram (XRAY). Constrictor position was identified in all animals by both techniques. The LCX proximal to the constrictor was visualized by MRA in all animals except those 3 animals with LCX occlusion by XRAY but the LCX distal to the constrictor was not well visualized.


Piotr Makowski, Steffen Ringgaard, Ernst Torben Fruead, Erik Morre Pedersen
1Technical University of Lodz, Lodz, Poland; 2Aarhus University Hospital, Aarhus N., Denmark

The abstract presents a novel approach to the segmentation of coronary arteries in MR images. The result of the segmentation in form of a triangular mesh (STL) represents the surface of the vessel. The 3D STL model has been used as geometric boundary condition for Computational Fluid Dynamics (CFD) simulations of velocity flow patterns and wall shear stresses in the right coronary artery. The model of the coronary artery is represented with a set of ellipsoids or spheres with centers along the vessel axis. The vessel surface is represented as a triangular mesh covering all ellipsoids.
Imaging the Vessel Wall

Room K  Monday 14:00 - 16:00

14:00  1900.  3D Volume Selective TSE for Carotid Artery Wall Imaging with Navigator Detection of Swallowing
Lindsey Alexandra Crowe1, Jennifer Keegan1, Peter Gatehouse1, Raad Mohiaddin1, Anitha Varghese1,
Karen Symmonds1, Timothy Cannell1, Guang-Zhong Yang2, David N. Firmin1
1Imperial College/Royal Brompton Hospital, London, UK; 2Imperial College, London, UK

3D volume selective TSE scans of the carotid artery can be affected by swallowing motion. A navigator accept/reject algorithm has been added to our carotid artery wall scanning and tested in 6 healthy volunteers. The use of navigators at the back of the tongue leads to a statistically significant increase in image quality by reduced blurring and a quantifiable reduction in signal intensity in the lumen. The increase in heart rate on swallowing is likely to affect blood suppression efficiency therefore it is desirable to remove data acquired during fast heart rate as well as during physical motion.

14:01  1901.  Identification and Removal of Residual Signal from Slow Flowing Blood in 3D Volume Selective TSE Arterial Wall Imaging using a Velocity Sensitive Phase Reconstruction Method
Lindsey Alexandra Crowe1, Raad Mohiaddin1, Anitha Varghese1, Guang-Zhong Yang2, David N. Firmin1
1Imperial College/Royal Brompton Hospital, London, UK; 2Imperial College, London, UK

A method is described for the identification of residual blood signal in 3D volume selective TSE imaging of the arterial wall. Slow, recirculating blood, in regions such as the carotid bifurcation, is not always fully suppressed by double inversion. A velocity sensitive bipolar pulse is added to the sequence and the resulting phase reconstruction images highlight slow flow. A phase threshold can be then be applied to the magnitude reconstruction images. Combination with an automatic segmentation method will reduce the limitations of shared pixels at the wall/lumen boundary and signal loss due to noise in the phase images.

14:02  1902.  MRI of Unstable Carotid Plaque: Correlation between Heavy T1-Weighted Imaging and Pathology
Naoaki Yamada1, Toshihiro Ishibashi1, Hatsue Ishibashi-Ueda1, Junichi Ayabe1, Katsuhiko Hayashi1,
Koji Iihara1, Masahiro Higashi1, Ryoichi Tanaka1, Chikao Yutani1, Hiroaki Naito1
1National Cardiovascular Center, Suita, Osaka, Japan; 2Jikei University School of Medicine, Tokyo, Japan

High signal intensity on heavy T1-weighted imaging can be related to ‘at risk’ carotid plaque. The purpose of this study was to determine pathological characteristics of the high signal. Surgically removed specimen and in vivo MRI were matched in 40 sections of 9 patients. In the results, high signal on T1-weighted imaging corresponded to lipid rich core with hemorrhage. Neither pure hematoma nor pure lipid rich core revealed high signal in this study group. High signal was not restricted to recent thrombus. However, the number studied is still small. Further investigation of the mechanisms of high signal is necessary.

14:03  1903.  Carotid Plaque Imaging: Source of Motion Artifact and Correction
Jean-Michel Serfaty1, Gwenael Herigault2, Romild Hoogeveen2, Chun Yuan1, Philippe Douek1
1Hôpital Cardiologique, Bron Lyon, France; 2Philips Medical Systems, Best and Toulouse, The Netherland and, France

The goal of the study is to investigate the potential sources of bad image quality in the wall imaging of carotid arteries and to suggest possible solutions. To achieve such a goal, we quantified carotid artery wall motion related to arterial pulsation, breathing, and swallowing. We also assessed whether the use of a navigator based sequence would result in a reduction of motion related to swallowing.

14:04  1904.  In Vivo Intravascular MRI: Evaluation of Vessel Wall Conspicuity Obtained in Multiple Contrast Imaging Protocols
Claudia M. Hillenbrand1, Jack A. Jesberger1, Eddy Y. Wong1, Frank K. Wacker1, Shaoxiong Zhang1,
David T. Chang1, Jonathan S. Lewin1, Jeffrey L. Duerk1
1University Hospitals of Cleveland, Cleveland, Ohio, USA

This study seeks to identify fast MRI sequences that provide high contrast, high SNR and high-resolution MR images of vessel walls when used in combination with endovascular imaging coils that are placed in the abdominal aorta in a porcine model. A set of 10 imaging protocols was employed over 13 trials, and analyzed by 6 expert readers. Rating objectives were: wall conspicuity, wall-to-lumen and wall-to-tissue contrast, clinical usefulness, and image quality. TrueFISP revealed the best results overall within the shortest imaging time but could not distinguish between wall layers.
14:05  **Comparison between Cardiac Gated and Non-Gated Multislice Black Blood Atherosclerotic Carotid Artery Imaging**

Venkatesh Mani¹, Vitalii V. Itskovich¹, Silvia H. Aguilar¹, Juan Gilberto S. Aguinaldo¹, Daniel D. Sambè², Gabor Mizsei¹, Marc Siról¹, Zahī A. Fayad³

¹Mount Sinai School of Medicine, New York, New York, USA

In this study, quality of multislice black blood imaging of carotid arteries is quantitatively and qualitatively assessed with and without cardiac gating on 4 atherosclerotic patients and 4 healthy volunteers using T2-weighted turbo spin echo sequences on a 1.5T MR scanner is tested. Non-gated sequences had higher SNR, higher CNR and fewer artifacts as compared to the cardiac gated sequences. Overall image quality, flow suppression and vessel wall delineation were similar for both gated and non-gated sequences. Non-gated sequences may be used instead of gated sequences for atherosclerotic carotid artery imaging, in progression/regression studies.

14:06  **Extended Coverage Black Blood Sequences for Atherosclerotic Plaque Imaging: Inflow Saturation Band and Double Inversion Recovery Rapid Extended Coverage Sequences Comparison**

Vitalii V. Itskovich¹, Venkatesh Mani¹, Silvia H. Aguilar¹, Juan Gilberto S. Aguinaldo¹, Daniel D. Sambè², Gabor Mizsei¹, Marc Siról¹, Zahī A. Fayad³

¹Mount Sinai School of Medicine, New York, New York, USA

In this study, quality of fast interleaved double inversion recovery rapid extended coverage (REX) and inflow/outflow parallel saturation band black blood multislice imaging of carotid arteries on 4 atherosclerotic patients and 2 healthy volunteers using T2-weighted turbo spin echo sequences on a 1.5T MR scanner is qualitatively and quantitatively compared. Qualitatively, there was no significant difference between overall image quality, flow suppression and vessel wall delineation between the two multislice black blood techniques. SNR was significantly higher to inflow/outflow saturation sequences while artifacts were significantly fewer DIR-REX sequences as compared.

14:07  **T2* Weighting in Fast Spin Echo Images**

W Thomas Dixon¹, Christopher J. Hardy², Xuli Zong¹, Daniel J. Blezek³, Subba V. Raman³

¹GE Global Research, Niskayuna, New York, USA; ²Ohio State University, Columbus, Ohio, USA

Fast spin echo imaging provides T2 weighted images rapidly, but not generally T2* weighted images. Shifting the time of the initial 90º pulse adds T2* weighting to FSE images. Even and odd lines of k-space are inequivalent, producing ghosts, but T2* contrast can be stronger than the ghosts, depending on T2* values in the region of interest. The amount of T2* weighting is not limited by the time between 180º pulses as with some other methods. T2* weighting is sensitive to deoxygenated blood, endogenous iron deposits, and superparamagnetic contrast agents. Our application is black-blood, carotid artery wall imaging.

14:08  **Quantitative Evaluation of Fibrous Cap Status in MRI of Carotid Atherosclerosis**

Niranjan Balu¹, William S. Kerwin¹, Marina S. Ferguson¹, Chun Yuan¹

¹University of Washington, Seattle, Washington, USA

Weakened or disrupted fibrous caps (FC) of carotid atherosclerotic lesions are linked to future strokes. An objective means of quantifying FC integrity can be used to assess plaque stability and select treatment. The method proposed here for non-invasively measuring FC status combines bright and black blood imaging with an automated classification algorithm to evaluate the integrity of each point along the lesion surface. The output is the proportion of the surface classified as a thick stable, thin weakened or ruptured caps. In vivo experiments are presented showing good correlation with subsequent histological evaluations.

14:09  **Evaluation of the Fibrous Cap Rupture of the Atherosclerotic Carotid Plaque by In Vivo Contrast-Enhanced High Resolution MRI**

Xin Lou¹, Jianming Cai¹, Youquan Cai¹, Tingjiang Zhao¹, Chun Yuan¹

¹The Chinese PLA General Hospital, Beijing, People's Republic of China; ²University of Washington, Seattle, Washington, USA

High-resolution MRI has shown to be capable of distinguishing intact fibrous cap from ruptured fibrous cap by TOF sequence. We compared the contrast enhanced MRI with TOF MRI in determining the fibrous cap rupture of the atherosclerotic carotid plaque. The results showed that there was a high level of agreement between CE MRI and TOF MRI with k value =0.80. High-resolution CE MRI is capable of determining the fibrous cap rupture.

14:10  **Carotid Plaque Imaging at 1.5T and 3T: Systematic SNR Comparison**

Masahiro Terashima¹, Patricia KP Nguyen¹, Vasily L. Yarnykh², Cecil E. Hayes², Ann Shimakawa¹, Jean Brittani¹, Chun Yuan⁵, Michael V. McConnell⁴

¹Stanford University, Stanford, California, USA; ²University of Washington, Seattle, Washington, USA; ³GE Medical Systems ASL West, Menlo Park, California, USA

High-resolution plaque imaging allows characterization of atherosclerotic plaque. We have adapted our dedicated phased-array carotid coil design and our multislice double inversion-recovery (DIR) black-blood imaging sequence to 3T. Multi-contrast carotid plaque imaging demonstrates substantially greater SNR (54%) at 3T. This may translate into improved characterization of carotid plaque, which will need to be demonstrated in patient studies.
Carotid atherosclerosis is a disease characterized by plaque formation leading to vascular stenosis and eventually to stroke. Quantification of plaque volume and content is important as a means for risk assessment and monitoring of treatment with lipid-lowering drugs. High-resolution MRI of the carotid arterial wall is demanding since it requires imaging at submillimeter pixel size at high enough SNR for exact quantification of plaque architecture and content. In the present work we investigate the improvement in performance at 3.0T relative to 1.5T using phased-array surface coils and demonstrate that the increased SNR can be traded for smaller voxel volumes.

A clinical protocol for multicontrast high-resolution imaging of the carotid artery (CA) wall has been optimized for 3T magnetic field. The protocol is based on a recently proposed multislice double inversion-recovery sequence for time-efficient black-blood imaging. Performance of CA imaging at 3T and 1.5T has been compared in a group of healthy subjects and atherosclerosis patients. Black-blood imaging of carotid arteries at 3T provides ~1.6 times increase of SNR and similar quality of blood suppression.

Thrombus imaging with several T2- and T1-weighted sequences has been suggested, but little is known about temporal evolution of the thrombus signal characteristics and the histological make-up to the thrombus. We developed a thrombus model in rabbits that closely resembles human venous stagnation thrombus of different organizational stages and used established thrombus imaging techniques. With both T1- and T2*-weighted techniques thrombi were only partially displayed. T1-weighted techniques are more effective, but strongly depended on thrombus age. Our data suggest that thrombus imaging may be insufficient for detecting thrombi, but may have a potential for characterizing thrombus organizational stage.

Thrombosis is a major cause of acute coronary syndromes and can be treated with thrombolytic therapy. A noninvasive approach to detect arterial thrombosis and response to thrombolysis would be beneficial. Using an in-stent thrombosis model, we evaluated MR angiography for the detection of in-stent thrombosis and serial monitoring of thrombolytic therapy. MRA findings indicative of in-stent thrombosis were seen within the stent at Day 1-2 post stenting. After thrombolytic therapy, a marked decrease in in-stent thrombosis was demonstrated with MRA sequences at 1-3 hours, with partial recurrence of thrombus by 24 hours.

Our experiments demonstrated the internalization of MGd by vascular endothelial and smooth muscle cells using confocal microscopy, and demonstrated an increased MR signal intensity for cells with internalized MGd. We also determined a suitable in vivo dosage of MGd for optimal internalization and enhancement. Vascular cells are shown to maintain a high level of internalized MGd for at least 24 hours post-contrast enhancement. These findings suggest that MGd can generate contrast between various vascular tissue types involved in atherosclerotic plaque, and may be useful for plaque characterization using high-resolution, contrast-enhanced MR vessel wall imaging.

USPIO enhanced MR imaging of human carotid atheroma has been validated as a tool to identify macrophages within symptomatic plaques. The present study was undertaken to address the issue of whether this tool could identify macrophages within vulnerable plaques in asymptomatic patients.
14:17  **1917. Reproducibility of Contrast Enhancement Parameters in Carotid Atherosclerosis**

*William Sean Kerwin¹, Chun Yuan¹*

¹University of Washington, Seattle, Washington, USA

This investigation evaluates the test-retest repeatability of dynamic contrast enhanced MRI for measuring contrast agent kinetics in advanced carotid atherosclerotic plaques. Contrast enhanced MRI is of considerable interest to the plaque imaging community because of its unique ability to identify plaque components such as neovasculature and because quantitative indexes of enhancement can be extracted and evaluated for clinical significance. One important question is whether such indexes are repeatable in multiple scans. This investigation shows that, for the plaque as a whole, the partial volume of blood plasma and the transfer constant are reproducible to within 16% and 17%, respectively.

14:18  **1918. Logistic Regression Analysis of Optimal MR Weighting Combinations for Atherosclerotic Plaque Assessment**

*Vincent Cappendijk¹, Fons Kessels², Sylvia Heeneman², Kitty Cleutjens², Geert Willem Schurink¹, Rob Welten³, Mat Daemen², Jos van Engelshoven¹, Eline Kooi¹*

¹University Hospital Maastricht, Maastricht, Limburg, Netherlands; ²Maastricht University, Maastricht, Limburg, Netherlands; ³Atrium Medical Center, Heerlen, Limburg, Netherlands

Qualitative MR assessment of atherosclerotic plaque already proved to be promising, but quantitative data and a systematic analysis of multisequence MRI is still lacking. In the present study quantitative data was obtained and optimal combinations of MR weightings were determined using logistic regression analysis.

14:19  **1919. Quantitative Assessment of Ultrasmall Superparamagnetic Iron Oxide (USPIO) Contrast Agent Uptake in Atherosclerotic Plaque by MRI**

*April D. Yancy¹, Alan Olzinski¹, Tom C-C Hu¹, Steve C. Lenhard¹, Karpagam Aravindhan¹, Paula Jacobs², Robert N. Willette¹, Beat M. Jucker¹*

¹GlaxoSmithKline, King of Prussia, Pennsylvania, USA; ²Advanced Magnetics, Inc., Cambridge, Massachusetts, USA

In the following study, we quantitatively assessed uptake of two different ultrasmall superparamagnetic iron oxide (USPIO) agents in atherosclerotic plaque by MRI. Balloon-injured rabbits received 500 μmol/kg Combidex® or ferumoxytol at 2, 4, and 8 weeks post-injury. In vivo and ex vivo MRI was performed on abdominal aorta and iliofemoral artery. The decreased MRI signal observed both in vivo and ex vivo was consistent with the absolute iron content in these vessels, as measured by ICP-MS. These findings indicate that quantitative assessment of active atherosclerotic lesion development using USPIO contrast based MRI is feasible.

14:20  **1920. Vascular Wall Area Measurement in Atherosclerotic Carotid Artery: Comparison between CTA and High-Resolution MRI**

*Jianming Cai¹, Li Yang¹, Youquan Cai², Chun Yuan²*

¹The Chinese PLA General Hospital, Beijing, People's Republic of China; ²University of Washington, Seattle, Washington, USA

Carotid wall area is a measure of atherosclerotic plaque burden. High-resolution MRI has been shown to be capable of accurately measuring the wall area of atherosclerotic human carotid artery. In this study, measurement of carotid vascular wall area has been compared between CTA and high-resolution MRI in 18 patients. Our result indicates that carotid vascular wall area can be measured accurately by both CTA and high-resolution MRI with comparable results.

14:21  **1921. Generation of Morphological Models of Atherosclerotic Arteries from High Resolution MR Images**

*Martin Auer¹, Rudolf Stollberger², Peter Reginig³, Gerhard A. Holzapfel¹, Franz Ebner²*

¹Institute for Structural Analysis – Computational Biomechanics, Graz, Austria; ²Abteilung für klinische und Experimentelle Magnetresonanzforschung, Graz, Austria; ³Institute of Pathology, Graz, Austria; ⁴Universitätsklinik für Radiologie, Graz, Austria

14:22  **1922. CASCADE: Computer Aided System for Cardiovascular Disease Evaluation**

*Dongxiang Xu¹, William S. Kerwin¹, Tobias Saam¹, Marina Ferguson¹, Chun Yuan¹*

¹University of Washington, Seattle, Washington, USA

The aims of this study are (1) to design and implement a quantitative vascular analysis system for atherosclerotic plaque tissue evaluation based on Multiple Contrast Weighting MRI; and (2) to validate the agreement of analysis results using histological examination as the gold standard.
The purpose of this study was the evaluation of a new MRI protocol for visualization of mural inflammatory changes of the temporal artery in giant cell arteritis. Our initial results demonstrate that high resolution MRI with sub-millimeter spatial resolution has the potential to visualize inflammation of the temporal artery. This might prove to be beneficial in the proper diagnosis, evaluation of the severity of the disease, and for non invasive follow up investigations. Larger patient trials will be needed to reliably assess the diagnostic value of MRI of the temporal artery in giant cell arteritis.

A nonparametric method for estimating arterial wall shear stress (WSS) from phase contrast MR images. Nonparametric function estimation does not require restrictive assumptions about the form of the blood velocity profile or symmetry of the vessel. In data from a phantom with a nonconvex cross-section, this method produced a good fit and sensible estimates of WSS. The main result of this abstract is to describe a nonparametric method and establish its feasibility for estimating WSS in blood vessels.

Atherosclerosis is a common risk factor for cardiovascular diseases. Good screening methods for risk groups are still lacking and the early manifestations of atherosclerosis can’t be seen with conventional methods such as angiography. MRI is a promising non-invasive screening tool for atherosclerosis. One approach in the imaging of atherosclerosis with MRI is measuring the elastic properties of aorta which are known to change with the accumulation of lipids to the intima. In our studies with familial hypercholesterolemia patients pulse wave velocity of the aorta increased and aortic compliance decreased with aging indicating stiffening of the vessel wall.

Regions of anomalous wall shear stress (WSS) have been shown to correlate with loci of plaque formation in vivo. A 3D PR phase contrast (PC) technique (PC-VIPR) was used to measure WSS in phantom and in vivo experiments. The 3D PC-VIPR was found to be accurate within 20% for the equivalent of a three minute scan covering a full 18 cm3 volume and less than 1% for a six minute scan. 3D PC-VIPR is a promising technique for measuring WSS due to its ability to acquire large 3D volumes at isotropic spatial resolution in reduced scan times compared to conventional PC sequences.

Demonstration of simultaneous acquisition of pulmonary artery pressure (invasive manometry) and flow using phase contrast MR, compared to the traditional technique based on the Fick principle.

Non-ferromagnetic, platinum-iridium alloy stents produce minimal artifact on MR and can be assessed by 3D MRA. In vitro phantom study demonstrates lumen visualization was maximized by aligning the long axis of the stent with the magnetic field, decreasing the slice thickness, and increasing the flip angle. Maximum SNR within the stent was observed at a flip angle of 60°. Compared to digital subtraction angiography, 3D MRA with optimized parameters successfully depicted 22 stents in 18 patients. The greatest accuracy was acquired using a 75° flip angle. On average, the difference between stenosis severity on MRA and DSA was 21% (0-75%).
14:06  **1929. MRI Compatibility of Endovascular Stentgrafts for Abdominal Aortic Aneurysm Repair**

Maarten J. Van der Laan1, Lambertus W. Bartels2, Chris J.G Bakker1, Max A. Viergever3, Jan D. Blankensteijn1

1University Medical Center Utrecht, Utrecht, Netherlands; 2Image Sciences Institute, Utrecht, Netherlands; 3University Hospital St. Radboud, Nijmegen, Gelderland, Netherlands

The evaluation of MRI characteristics of endovascular grafts used for abdominal aortic aneurysm repair that were commercially available. Seven endovascular grafts were placed in gadolinium-doped water and scanned using a 1.5-T clinical MR scanner. Two different scans were acquired for each endovascular graft: The scans were evaluated for susceptibility artifacts, radiofrequency shielding and caging artifacts. The ferromagnetic properties of the Zenith and the Lifepath devices make MR evaluation of endovascularly treated abdominal aortic aneurysms unfeasible. For the Ancure graft evaluation around the attachment sites might be problematic. In the other evaluated endografts, an MR based follow-up is a viable option.

14:07  **1930. MR Evaluation In Vivo of Nine Different Abdominal Aortic Stent Grafts: Assessment of Imaging Characteristics**

Axel Gossmann1, Michael Gawenda1, Karsten Krueger1, Markus Zaehring1, Jan Brunkwall1, Klaus Lackner1

1University of Cologne, Cologne, NRW, Germany

The aim of our study was to evaluate in vivo image artifacts in nine different stent grafts in patients with endovascular treatment of abdominal aortic aneurysms (AAA). All patients underwent MR angiography of the stent grafts and the image quality was assessed by four different readers. Stainless steel containing devices were found to be not suitable for follow up examinations of endoluminally treated AAA at MR angiography. Nitinol and elgiloy based devices are better suited for MR angiography, however, of the seven examined stent graft protheses, only three devices were found to provide a good diagnostic confidence.

**MR Angiography of Carotid Arteries**

Room K  Wednesday 13:30 - 15:30

13:30  **1931. The Value of Adding Axial Multiplanar Reconstruction Images to Coronal MIP Images at the Evaluation of Supraaortic Vessel Stenosis by Using 3D-CE-MRA: Comparison With Digital Subtraction Angiography**

Hale Musapasaoglu1, Ahmet Muhtesem Agildere1, Mehmet Teksam1, Cuneyt Aytekin1, Ali Fırat1, Fatih Boyvat1

1Baskent University, Ankara, Turkey

Aim is to estimate the value of adding axial multiplanar reconstruction and subtraction images to coronal MIP images at the quantitative evaluation of supraaortic vessel stenosis by using 3D-CE-MRA. Supraaortic vessels were evaluated on coronal MIP, axial MPR and subtraction images. Results were compared with DSA. Adding axial MPR images to coronal MIP reconstructions increases the specificity to 90.5% from 75% at the evaluation of ICA stenosis. Evaluation with subtraction images increases k coefficient to 0.812 from 0.735 at the evaluation of ICA. Adding axial MPR or subtraction images to coronal MIP reconstructions increases the usefulness of the technique.


Niranjan Balu1, William S. Kerwin1, Chun Yuan1

1University of Washington, Seattle, Washington, USA

Recent studies show that bifurcation angle (BA) is an important determinant of carotid atherosclerosis. While these studies were done on patients with early atherosclerosis, no study has been done to indicate whether BA continues to play a role in advanced disease. Another disadvantage of previous studies where BA was measured from radiographic projections and ultrasound insonations, is that they are more observer dependent than the method described herein which measures angles between arterial segments from axial MR slices. The BA in advanced atherosclerosis was found to correlate well with plaque burden in the common and internal carotids.


Jean Marie U-King-Im1, Martin John Graves1, Rikin Trivedi1, Peter Kirkpatrick1, Nagui Antoun1, Jonathan Gillard1

1Addenbrooke's Hospital, Cambridge, Cambridgeshire, UK

Contrast-enhanced MRA has emerged as the non-invasive modality of choice for carotid atherosclerotic disease. MRA however, has a tendency to overestimate severity of stenosis compared to conventional intra-arterial angiography. There is limited evidence that review of MR source images may improve accuracy of diagnosis. However, this process is time-consuming and impractical using current workstation. This study clinically evaluates the use of a semi-automated vessel tracking algorithm which facilitates source image review and demonstrate that this is associated with improved diagnostic specificity compared to manual measurements on Maximum Intensity Projection.
13:33  **1934.** **Black-Blood Vessel Wall Imaging of Carotid Arteries; Correlation with Pathological Findings**
Masako Nagayama1, Yuji Watanabe1, Takashi Tabuchi1, Kazumichi Yoshida1, Akira Okumura1, Yoshiki Amoh1, Hideki Mitsui1, Noriyoshi Morimoto1, Shinsuke Komaki1, Kazuaki Nakada1, Masayuki Kumashiro1, Takashi Kiyono1, Makoto Ohara2, Marc Van Cauteren3, Sen Yamagata1, Yoshihiro Dodo1
1Kurashiki Central Hospital, Kurashiki, Okayama, Japan; 2Philips Medical Systems, Minato-ku, Tokyo, Japan; 3Philips Medical Systems, Best, DA, Netherlands

The purpose of this study was to assess the signal intensities of soft and hard plaques on Black-blood (BB) MR images and investigate possibility for differentiation between soft plaque and hard plaque. Fifteen patients who underwent BB-MR imaging and carotid endarterectomy with histological examination were assessed. High-resolution BB-MR imaging was performed using double inversion recovery technique. Plaques were classified into soft or hard according to intraoperative and/or pathological findings. Hyperintense plaques on BB-T1WI and/or BB-T2WI were soft plaque. Hypointense plaques on BB-T2WI were hard plaque.

Fadi Paul Glor1, Ben Ariff2, Lindsey A. Crowe3, Pascal René Verdonck1, Alun D. Hughes4, Simon A. Thom4, David N. Firmin1, X Yun Xu
1Ghent University, Ghent, Belgium; 2St Mary's Hospital, Imperial College London, London, London, UK; 3Royal Brompton and Harefield NHS Trust, Imperial College London, London, UK; 4St Mary's Hospital, Imperial College London, London, UK

Both Time-Of-Flight (TOF) and Black Blood (BB) MRA have been used for 3D carotid geometry reconstructions and, when coupled to computational fluid dynamics, for in vivo blood flow visualisation. In this study, eight young hypertensive subjects were scanned both with a BB and a TOF protocol. It was found that although BB allowed higher in-plane resolution, estimation of the intima-media thickness (IMT), and only a slight increase in acquisition time when gated, TOF yielded better geometry reliability. This was mainly due to poor BB image quality in the carotid branches.

### Body MR Angiography: Established Indications and New Techniques

Room K  Wednesday 13:30 - 15:30

13:30  **1936.** **Improved Venous Suppression with SENSE in Elliptical Centric Contrast-Enhanced MR Angiography**
Houchun Harry Hu1, Ananth Jayasseelan Madhuranthakam1, David G. Kruger2, James F. Glockner2, Stephen J. Riederer1
1Mayo Clinic College of Medicine, Rochester, Minnesota, USA

Recently the parallel-imaging method SENSE has been developed to improve efficiency in MRI, allowing reduced acquisition time or improved spatial resolution in various clinical applications. The ability of SENSE to improve spatial resolution is significant in contrast-enhanced MR angiography, where an intravenously administered contrast bolus flows through the vasculature during a limited time window. This work addresses our finding that using Cartesian SENSE in conjunction with elliptical-centric (EC) view order in CE-MRA yields superior venous suppression and provides enhanced spatial resolution in comparison to non-SENSE EC acquisitions of the same scan duration. K-space analysis and experimental images are presented.

13:31  **1937.** **Interactive Visualization of Time-Resolved 3D MRA on Commodity PC Hardware**
Ethan K. Brodsky1, Michael J. Redmond1, Frank J. Thornton1, Leo P. Flynn1, Derek Seeber2, Thomas M. Griss1, Walter F. Block1
1University of Wisconsin, Madison, Wisconsin, USA; 2IGC Medical Advances, Inc., Milwaukee, Wisconsin, USA

MR angiography techniques such as VIPR can generate time-resolved 3D images over a large FOV. Limited multiplanar reformating is essential for efficient diagnosis, but current commercial workstations offer low frame rates for interactive manipulation, offer poor support for time-resolved datasets, are expensive, and often have limited research access. We demonstrate interactive visualization of time-resolved 3D MRA, with MIPs of 256x256x256 volumes using arbitrary cut-planes and viewing angles, at frame rates in excess of 10 fps on inexpensive PC hardware. The techniques take advantage of modern PC graphics cards to increase performance and reduce software complexity by doing calculations in hardware.

13:32  **1938.** **Contrast Dose Optimization in MR Angiography (MRA) of the Carotids**
Johannes M. Froehlich1, Martin Unterweger2, Thomas Huber2, Rainer Otto3, Rahel A. Kubik-Huch2
1Guerbet AG, Zürich, Switzerland; 2Cantonal Hospital Baden, Baden, Switzerland

Various dose recommendations ranging from fixed volumes to weight adapted dosing are used clinically for MRA. Acquisition times, contrast flow-rate and injection duration are important factors which influence the needed contrast volumes. The aim of this study with 120 consecutive randomized patients was to compare MRA of the carotid arteries with single- versus double-dose gadolinium by assessing qualitative criteria, signal-to-noise, contrast-to-noise ratio correlated to the injected volume. Diagnostic performance and CNR of single-dose carotid MRAs are comparable with double-dose. Nevertheless, CNR is significantly lower in heavier patients for both dose-groups. This subgroup could potentially benefit from higher dosing.
13:33 1939. Renal MR Angiography with Steady-State Free-Precession (SSFP) and Slice-Selective Spin Inversion Combined with Radial k-Space Sampling and Water-Selection Excitation

Marcus Kato1, Elmar Spuentrup2, Matthias Stuber1, Romhild Hoogeveen1, Rolf W. Guenther1, Arno Buecker1
1RWTH Aachen University Hospital, Aachen, Germany; 2Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; 3Philips Medical Systems, Best, Netherlands

We investigated the impact of radial k-space sampling and water-selective excitation on a novel navigator-gated cardiac-triggered 3D steady-state free-precession (SSFP) renal MR angiography technique, which uses a slice-selective inversion pulse for high contrast visualization of the renal arteries. In four volunteers and four patients this approach was investigated using Cartesian and radial SSFP, and radial SSFP with water-selective excitation. SNR and CNR as well as vessel border definition were analyzed. All sequences allowed for high-contrast and selective visualization of the renal arteries. However, superior SNR, CNR, and vessel sharpness was found for standard Cartesian SSFP imaging.

13:34 1940. Contrast-Enhanced MR Angiography of the Renal Arteries: Blinded Multicenter Crossover Comparison of 0.1 mmol/kg Gadobenate Dimeglumine (Gd-BOPTA) and 0.2 mmol/kg Gadopentetate Dimeglumine (Gd-DTPA)

Matthias Prokop1, Mathias Goyen1, Philippe Douek2, Angelo Vanzulli4, Gunther Schneider9
1University Medical Center Utrecht, Utrecht, Netherlands; 2University Hospital Essen, Essen, Germany; 3University of Lyon, Lyon, France; 4Niguarda Hospital, Milan, Italy; 5Universitaetskliniken des Saarlandes, Homburg/Saar, Germany

Thirty-four patients underwent two identical contrast-enhanced MRA exams of the renal arteries. Gd-DTPA at 0.2 mmol/kg was used for one exam and Gd-BOPTA at 0.1 mmol/kg for the other. The CM were administered in randomized order at 2 ml/s. Qualitative evaluation by two independent blinded assessors revealed no significant differences in image quality between the two exams. Quantitative evaluation at regions-of-interest on the supra-, juxta- and infrarenal aorta revealed similar values for signal-to-noise and contrast-to-noise ratios. A trend towards increasing SNR and CNR on descending the aorta was apparent after 0.1 mmol/kg Gd-BOPTA but less so after 0.2 mmol/kg Gd-DTPA.

13:35 1941. MR Assessment of Renal Artery Stenosis Compared to Conventional X-ray Angiography: Clinical Experience in 134 Patients

Juan Carlos Rozo1, Brenda Lambert1, Eduardo Hernandez1, Veronica Lenge1, Mercedes Pereyra2, Raja Mudhupillai2, Scott D. Plam1
1St. Luke's Episcopal Hospital, Houston, Texas, USA; 2Baylor College of Medicine, Houston, Texas, USA

Contrast Enhanced MRA (CE-MRA) continues to gain wider clinical acceptance for assessing renal artery disease. The combination of anatomic information from CE-MRA and qualitative flow information from phase contrast imaging (PVM) can be used to assess the hemodynamic significance of renal artery stenoses. The purpose of this study was to compare the sensitivity and specificity of 3D contrast enhanced magnetic resonance angiography in diagnosing renovascular disease against conventional X-ray angiography (XRA) in patients with suspected renovascular hypertension. Results from 134 clinically referred patients imaged over a three-year period are presented.


Albert Tseng1, Christina Pinto2, Richard McCarthy2, Reed Omary2, Mark Morasch3, James Carr2
1University of Illinois, Chicago, Illinois, USA; 2Northwestern University Medical School, Chicago, Illinois, USA

The purpose was to evaluate the ability of lower extremity CEMRA to detect intraluminal thrombus and to correlate this with the clinical presentation of the patient. 108 LE-CEMRA studies were retrospectively reviewed the presence of thrombus in arterial occlusions was noted. The majority of patients with continuous intraluminal thrombus visualized within an arterial occlusion had an acute presentation. Most of those with discontinuous or no thrombus had chronic presentations. Identification of intraluminal thrombus in arterial occlusions is a useful marker of acute ischemia and helps identify this subgroup for treatment with less invasive intra-arterial thrombolysis rather than surgery.

13:37 1943. Clinical Comparison of the Hybrid Peripheral Magnetic Resonance Angiography Technique versus Sequential Stepping-Table Approach

Frederick Scott Pereles2, Jeremy Douglas Collins1, James C. Carr1, Mark Morasch2, Chris Francois1, Amar Singh1, Elizabeth Krupinski1, Paul Finn1
1Northwestern University, Feinberg School of Medicine, Chicago, Illinois, USA; 2The University of Arizona, Tucson, Arizona, USA; 3UCLA, Los Angeles, California, USA

Our study compares a novel hybrid peripheral MR angiography technique with standard bolus chase methods. The hybrid technique showed greater sensitivity, specificity and accuracy than bolus chase. The hybrid technique is applicable to 1.5T imaging on any machine regardless of vendor type.

13:38 1944. Interactive MRA using Ungated Single-Shot Half-Fourier Projection RARE

David J. Lomas1, Martin J. Graves1, Richard T. Black, Ilse Joibert1
1University of Cambridge & Addenbrooke's Hospital, Cambridge, UK

An ungated unenhanced projection angiographic technique based on single-shot half-Fourier RARE integrated with an interactive imaging interface and “on the fly” subtraction processing is described. The implementation on a commercial 1.5T MR system is outlined and rapid interactive imaging and identification of the peripheral arteries demonstrated in the leg and wrist in volunteers.
Mitsue Miyazaki1, Yoshimori Kassai1, Hitoshi Kanazawa1, Satoshi Sugiyama1, Hirofumi Wada1, Joji Urata2
1Toshiba Medical Systems, Otawara, Tochigi, Japan; 2Saiseikai Kumamoto Hospital, Kumamoto, Japan

Separation of arteries from veins can be achieved in non-contrast-enhanced peripheral MRA using ECG-triggered 3D half-Fourier FSE with read-out (RO) spoiler gradient pulses. However, the separation was limited to only the head-to-foot direction or the RO direction. Most of peripheral vessels are oriented in the head-to-foot direction; however, some arterial branches are oriented in the right-left direction. In this study, an additional PE spoiler gradient pulse was implemented in half-Fourier FSE and the technique gave better delineation of peripheral arteries oriented in the both directions.

David A. Woodrum1, Utpal H. Pandya1, David Brosh1, Phillip J. Rossman1, Amir Lerman1
1Mayo Clinic, Rochester, Minnesota, USA

Hypertension affects millions of people and is one of the most important risk factors in the subsequent development of cardiovascular diseases leading to premature death. Magnetic resonance elastography (MRE) is a new technique to image tissue motion, enabling the imaging of the physical properties of tissue such as stress and strain. Our hypothesis is that MRE can be used to image early hypertensive changes enabling targeted therapy and prevention of secondary cardiovascular disease. We utilize MRE techniques to first establish a vessel model and then apply the methods to ex vivo porcine aorta tissue.

Yuexi Huang1, David Gur1, Jean Brittain1, Robert Herfkens2, Naeem Merchant1, Graham Wright1
1University of Toronto, Toronto, Ontario, Canada; 2GE Medical Systems, Menlo Park, California, USA

Rotational projection imaging acquires high spatial-resolution projection images at a high temporal resolution from multiple angles. 3D data can be reconstructed in a sliding-window fashion by combining multiple projections. The feasibility of achieving both sub-mm spatial resolution and sub-second temporal resolution with 3D information in contrast-enhanced MRA is demonstrated by phantom and volunteer studies. Rotational projection imaging provides a new way of imaging dynamic 3D information with high spatial resolution.

Kai-Uwe Walschus1, Markus Jochims2, Oliver Bruder2, Thomas Schlosser2, Georg V. Sabin2, Jörg Barkhausen1
1University Hospital, Essen, NRW, Germany; 2Elisabeth Hospital, Essen, NRW, Germany

Radio-frequency catheter ablation (RFCA) of the pulmonary veins (PV) is a promising interventional technique in patients with symptomatic refractory paroxysmal atrial fibrillation. Imaging of the pulmonary veins is crucial in these patients because knowledge of PV-variants and PV-orifices diameters are prerequisites for a successful intervention. Post-interventional follow-up examination are mandatory to detect post-interventional complications. Our data show that contrast enhanced 3D-MRA is an excellent non-invasiv imaging technique which is superior to trans-esophageal echocardiography (TEE) and should be considered as the imaging modality of first choice in these patients.

Ben Hui1, Michelle Noga1, Alan Wilman1
1University of Alberta, Edmonton, Alberta, Canada

Navigator gated 3D MR Angiography (MRA) of the pulmonary vasculature using steady-state free precession (SSFP) is evaluated against a 30 second breathhold version of the same technique in 10 normal volunteers. The navigator technique made use of a navigator both immediately before and after each segmented SSFP playout of 99 imaging views. The results indicate that the navigator technique can be as effective as a breathhold technique.

Jaroslav Tintera1, Robert Cihak1, Pavel Fendrych1, Eva Rolencova1, Vaclav Porod1, Hana Mlcochova1, Josef Kautzner1
1IKEM, Prague, Czech Republic

Contrast enhanced MRA was used to compare the pulmonary veins cross-sectional area (CSA) before and after the RF ablation and also 3 months later. Immediately after RF ablation, 5 (8%) significant stenoses were found. However we also found diffuse decrease of CSA down to 50-80% in next 20 veins (31%). Only 8 subjects from 16 could be examined also after 3 months. During the follow-up control, an improvement was found in 7 cases of CSA mild reduction (from 11 affected veins in the post-ablation control) but both checked veins previously reported with high degree stenosis remained unchanged.
**Poster Sessions**

13:45  **1951. Non-Contrast MR-Angiography Compared to Contrast-Enhanced CT-Angiography in the Diagnosis of Pulmonary Embolism: Preliminary Results**  
*Alain Mayer*, *Remigio De Paoli*, *Mario Manganiello*, *Luigi Martella*, *Guido Robotti*  
1Lugano Hospital Civico, Lugano, Switzerland

BACKGROUND: Non-contrast MRA for pulmonary embolism could be very useful in patients with contraindications to contrast-CTA like adverse reactions, pregnancy, refusal to receive contrast or severe cardiovascular disease. METHODS: 10 patients underwent non-contrast MRA and contrast-CTA for pulmonary embolism. The scans were analyzed independently in blinded fashion. RESULTS: 6 patients were positive for pulmonary embolism. Sensitivity/specificity at following levels were: main pulmonary arteries 100%/100%, lobar pulmonary arteries 95%/100%, segmental pulmonary arteries 42%/97%, all pulmonary arteries 64%/98%. CONCLUSIONS: Non-contrast MRA is a valuable method in the diagnosis of pulmonary embolism in patients with contraindications to contrast-CTA.

13:46  **1952. Pulmonary MR Angiography in 50 Patients: Clinical Experience**  
*James F. Glockner*, *Thanila A. Macedo*  
1Mayo Clinic, Rochester, Minnesota, USA

Pulmonary MRA is an effective alternative to CTA in patients with suspected pulmonary embolus who have contraindications to CTA.

*Ross Venook*, *Greig Scott*, *Steven Conolly*  
1Stanford University, Stanford, California, USA

Using a prepolarized MRI scanner, with its polarizing magnet removed from the homogeneous acquisition region, we investigated remote polarization as a contrast method for angiography. By limiting spin magnetization to a region upstream of the ROI, only those spins within vessels will provide MR signal after the prescribed waiting time. The data presented here confirms that remote polarization can create contrast with constant flow rates. Further investigation with pulsatile flow phantoms, and further development of flow-robust sequences are necessary to validate this as a method for extremity angiography.

**Rapid Imaging and Gating Methods**

Room K  Thursday 13:30 - 15:30

*Girish Narayan*, *Krishna Nayak*, *John Pauly*, *Bob Hu*  
1Stanford University, Palo Alto, California, USA

Quantitative assessment of RV and LV volume in heart failure patients remains difficult given the length of acquisition, need for multiple breath-holds, and sensitivity to arrhythmias. We have developed a new real-time technique that provides complete 4-dimensional volumetric and functional information in a single breath-hold. In comparison with the gold standard segmented k-space technique, the new strategy is accurate and highly time efficient while requiring only a single patient breath-hold.

*Andrew Christian Larson*, *Peter Kellman*, *Andrew Aral*, *Glenn A. Hirsch*, *Elliot McVeigh*, *Orlando Simonetti*  
1National Institutes of Health, Bethesda, Maryland, USA; 2Siemens Medical Solutions, Chicago, Illinois, USA

Breath-holding continues to be a problematic aspect of cardiac cine-MRI. While real-time techniques can eliminate the need for breath-holding, segmented techniques provide higher SNR, temporal and spatial resolution. Conventional NAV techniques are not applicable to TrueFISP cine. A new respiratory self-gated cine technique derives gating information from projection reconstruction imaging data. This technique was compared with breath-hold and free-breathing averaging approaches in 6 volunteers in short-axis and long-axis orientations. Qualitative and quantitative metrics demonstrated comparable quality between breath-hold and self-gated images with significant improvements over simple averaging. Respiratory self-gating shows the potential to remove the need for breath-holding for cine-MRI.

*Ajit Shankaranarayanan*, *Andres Carrillo*, *Phil Yang*, *Mike McConnell*, *Jane Johnson*, *Jean Brittain*, *Bob Hu*  
1GE Medical Systems, Menlo Park, California, USA; 2Stanford University, Palo Alto, California, USA; 3Palo Alto Medical Foundation, Palo Alto, California, USA

A new integrated cardiac suite for performing comprehensive cardiac examination has been described. The integrated cardiac suite has modes to perform evaluation of ventricular function, cardiac morphology, coronary artery anatomy, valvular morphology and myocardial viability. Results, showing the mean times to perform individual applications and complete cardiac exam, from volunteer experiments is also presented.
Multiple-breath-hold functional cardiac imaging can be time-consuming and exhausting and can result in slice misregistration. Single-breath-hold methods have been explored; however, they can entail long breath-holds and low spatial and/or temporal resolution. 2D methods can be more flexible and robust than 3D for breath-hold cine imaging but require extra time to set each slice to steady state individually. Using a more efficient approach to steady state for successively acquired slices, Steady-State-Prepared FIESTA (FIESTA-SP) can image a slice every 2 heartbeats, thus allowing high-temporal-resolution whole-heart cine imaging in a single breath-hold.

A new method for ventricular assessment using “triggered” real-time imaging is described. Real-time, ungated imaging is used to localize the desired short and long axis slices. A single mouse click switches the acquisition to a high-resolution cardiac-gated CINE mode that acquires one slice per R-R interval and acquires all prescribed slices within a single breath-hold. This new “triggered” real-time method alleviates sensitivity to arrhythmia since all data for a given slice is acquired in a single R-R period and all slices are spatially registered since they are acquired in a single breath-hold. Example short-axis and long-axis images are presented.

Cardiac gating is an essential component of MR cardiac imaging to minimize motion-artifacts. The traditional method involves using the R-peak of an electrocardiogram (EKG) signal for acquisition synchronization. However, at field strengths 1.0T or higher, artifacts induced in the EKG result in poorly gated cardiac studies. We hereby propose a novel method using a mechanical sensor for cardiac gating. The mechanical sensor being a highly sensitive device can easily detect the true motion of the heart. By design, the sensor is immune to all noise sources on any system configuration thereby ensuring reliable triggering of the system.

A new approach to cardiac and interventional imaging is presented fusing two imaging technologies by simultaneously performing ultrasound (US) imaging inside the magnet during MR imaging. In this work, we show preliminary results for US-guided MRI by using position and orientation information extracted from US data to update imaging slice information in real-time. We also describe how to improve tracking efficiency by using a simple predictive model. Effective prospective motion compensation is shown for a phantom whose sinusoidal displacement can be fully corrected.

Mechanical gating allows the user to visualize both systolic and diastolic parts of the cardiac cycle. This will improve upon techniques such as the Fat-sat SSFP 3D technique, which rely on imaging in the diastolic region of the heart cycle. Furthermore, used in conjunction with standard ECG gating, on hard to image patients, this will improve the performance of triggering the system. Also important is the simultaneous acquisition of the respiratory signal, which can be used instead of a bellows system.

Free breathing cardiac imaging depends on navigator gating and tracking. During tracking the cardiac motion is assumed to be related to diaphragm motion by a constant scaling factor (usually 0.6). Regional and inter-patient variations in this scaling factor are known to cause degradation of image quality. In this study we present an automatic retrospective method for correcting some of the artifacts caused by the variations in the navigator scale factor. The study shows that the method can increase the image quality of in-vivo cardiac images.

Evaluation of a new method obtaining column spin-echo diaphragm navigator during continuous SSFP cine cardiac imaging. Although artifacts were comparable with the “flip-back” navigator, SSFP stabilisation artifacts in the new method remain unsolved.
Recent studies of BOLD contrast in the heart have shown best results using T2 imaging. However, sensitivity remains limited by physiological noise from beat-to-beat motion. Here, we have evaluated the combined use of parallel acquisition technique and single-shot multi spin echo EPI to reduce the acquisition of the myocardial T2 decay within a single heart beat and to repeat measurements at shorter time intervals. Human T2 myocardial data were collected under different respiratory modes and compared to T2 data obtained with TE stepping spin echo EPI. SNR improvement of 40 % was demonstrated with the multi-echo EPI method.

Dynamic Contrast MR Imaging of Cancer: Methods

Room 509  Tuesday 13:30 - 15:30

13:30  1965. Does Measurement of the Arterial Input Function Improve the Correlation between Tumor Microvessel Density and MR-Derived Perfusion of Small Molecular Extracellular Gd Chelates?
Greg O. Cron1, Christina Addison2, Julia C. Wallace3, Ruth C. Wilkins2, Teresa Fortin1, Bruce A. Pappas1, Frederick Kelcz4, Giles E. Santyr1
1Carleton University, Ottawa, Ontario, Canada; 2Ottawa Regional Cancer Centre, Ottawa, Ontario, Canada; 3Health Canada, Ottawa, Ontario, Canada; 4University of Wisconsin - Madison, Madison, Wisconsin, USA

Small molecular extracellular Gd chelates are often used for quantitative dynamic contrast-enhanced MRI of tumor perfusion. For such studies, the MRI-derived perfusion parameter Ktrans usually does not correlate with microvessel density (MVD). However, few of these studies involve careful measurements of the arterial input function (AIF), thereby leaving Ktrans vulnerable to significant (>30%) random errors. The purpose of this study was to determine if the correlation between Ktrans and MVD can improve with careful AIF measurements for R3230 tumors implanted in male F344 rats. Despite accurate AIF measurements (5%), there was still no correlation between Ktrans and MVD.

Niels Oesingmann1, Alto Stemmer1, Stefan Schoenberg1, Jeffrey Goldman3, Berthold Kiefer3
1Siemens AG Medical Solutions, Erlangen, Germany; 3Mount Sinai School of Medicine, New York, New York, USA

Subject of this work is the measurement of the signal-time-course of various tissues of the body after application of a contrast agent. We suggest using a combination of breath-hold and respiratory triggered acquisition. The fast signal changes during first pass are scanned during breath-hold with the fastest possible image sampling rate, automatically followed by a respiratory triggered scan. The following slower signal evolution is sampled with the period of the patients respiration at almost identical positions using a 2-dimensional navigator echo technique. Signal fluctuations due to through plane motion and image registration requirements are minimized.

Judith U. Harrer1, David L. Buckley2, Hamied A. Haroon2, Karl Embleton2, Caleb Roberts2, Danielle Balériaux3, Alan Jackson2, Geoff J.M. Parker2
1Aachen University Hospital, Aachen, Germany; 2University of Manchester, Manchester, UK; 3Hopital Erasme, Clinique Universitaires de Bruxelles, Bruxelles, Belgium

Summary: Estimates of vascular permeability (volume transfer constant (Ktrans) and fractional blood plasma volume (vp)) were analyzed in 18 gliomas using Tofts and Kermode's model (TK, without arterial input function (AIF)), a modification of TK including individual AIF and vp (mTK) and a 'first-pass' variant of this model (FP) applied to T1-weighted DCE-MRI. KTK was considerably higher than KmTK and KFP (p<0.001). KmTK and KFP were closely correlated (coeff=0.744) as were vp(mTK) and vp(FP) (coeff=0.901). Both methods incorporating individual AIFs and vp provide similar pathophysiological information, avoid erroneous overestimation of Ktrans, hence allowing more accurate estimation of endothelial permeability.

David L. Buckley1, Geoff JM Parker1
1University of Manchester, Manchester, UK

Accurate measurement of T1 is an essential step in the quantitative analysis of dynamic contrast-enhanced MRI. However, errors in B1 may propagate into these estimates particularly when variable flip angle spoiled gradient echo imaging is employed. In this study, the effect of a systematic error in B1 on the measurement of contrast agent uptake was examined. Errors of up to 40% in the estimates of tracer kinetics parameters result from imperfect B1 pulses. These errors can be significantly reduced when the tissue and arterial input curves are measured concurrently and both used for data analysis.

Charles S. Springer, Jr., Thomas E. Yankeelov, Xin Li, William D. Rooney, Daniel C. Medina

1Oregon Health & Science University, Portland, Oregon, USA; 2Vanderbilt University, Nashville, Tennessee, USA; 3Brookhaven National Laboratory, Upton, New York, USA; 4Columbia University, New York, New York, USA

The NMR “shutter-speed” for equilibrium transcytolemmal water exchange varies in the time period following bolus contrast reagent (CR) injection. The analytical expressions for this are given here. This allows the understanding and defining of how the system moves through sequential exchange “regime changes.” The exchange reaction can appear to slow down, and then speed back up as CR washes in and out of the interstitium.


Carsten Dan Ley, Lise Vejby-Sogaard, Helle Jul Simonsen, Paul E. Kristiansen, Ian J. Rowland

1Institute for Molecular Pathology, Copenhagen, Denmark; 2Danish Research Centre for Magnetic Resonance, Hvidovre, Denmark

A reproducible angiogenesis assay that may be studied non-invasively using MR methods would be of significant use. Towards this aim, we have evaluated a Matrigel chamber model where plastic cylinders containing Matrigel are implanted sub-cutaneously in nude mice. The inclusion of substances such as VEGF and bFGF within the Matrigel induces neoangiogenesis. Here, we show that high resolution MR images may be obtained from the implants both ex vivo and in vivo and that they may be studied using dMRI. This study suggests that Matrigel implants could be used to assess and optimize the efficacy of vascular targeted drugs.

13:36  1971.  **Fractal Analysis of Parametric Images Derived from Dynamic Contrast Enhanced MRI Data In Vivo**

Simon Walker-Samuel, James d'Arcy, Andrzej Dzik-Jurasz, Martin O. Leach, David J. Collins

1Institute of Cancer Research, Sutton, UK

The role of methodologies involving dynamic contrast-enhanced DCE-MRI in the functional evaluation of response to therapy and the detection of malignant tumours is increasing. Parametric images derived from model fitting of DCE-MRI data obtained in vivo from tumours are often characterised by a high degree of heterogeneity. Currently, analytical strategies available to assess such morphological measures of functional heterogeneity remain limited. We have used a fractal-based approach to assess the morphological features in parametric maps derived from the area beneath a gadolinium-time curve in adult brain tumours. These parameters could be used as novel prognostic or response parameters.


Thomas Kogler, Johann Raith, Stephen Keeling, Franz Payer, Rudolf Stollberger

1Graz Medical University, Graz, Austria; 2University of Graz, Graz, Austria

Tumor angiogenesis, usually a significant sign of tumor growth, is reflected by a change of different vascular parameters including blood flow, blood volume and the permeability-surface area product. In this regard, quantitative separation of blood flow and permeability-surface area product is crucial for the analysis of dynamic contrast enhanced MRI data. However, common models don’t always include physiological meaningful parameters. We provide data from numerical simulations and in vivo data showing that model deviations are up to 30% in concentration-time curves for a representative arterial input function and up to 40% in parameter estimations for measured dynamic MR data.


1Vanderbilt University, Nashville, Tennessee, USA

Dynamic contrast enhanced MRI (DCE-MRI) may be used to assess tumor perfusion, microvascular wall permeability, and extracellular volume fraction. Quantitative analysis of DCE-MRI data is based on indicator dilution theory, requiring measurement of contrast reagent concentration in blood plasma, [CrP], the so-called arterial input function (AIF). The inherent difficulties in accurately measuring the AIF frequently confound the analysis and interpretation of DCE-MRI data. We present here a method that employs a well-characterized reference region from which to “calibrate” the curve shape of the tissue of interest (tumor locus), effectively obviating the AIF measurement. We apply this method to a Lewis Lung Carcinoma mouse model to show that longitudinal tumor changes can be measured without an AIF.
Measurement and analysis methodology for the application of dynamic contrast enhanced MRI (DCE-MRI) for antivascular cancer treatment has been the subject of several consensus meetings. The need to have reproducibility data to allow individual and intergroup comparisons with a uniform statistical approach was emphasised. We report the reproducibility of multiparametric data acquired from T1 (Ktrans, ve, kep, max Gd concentration, mean gradient, maximal signal amplitude, IAUGC) and T2*-weighted (rBV, rBF, MTT) DCE-MRI examinations and non-contrast R2* measurements, in breast and abdominal tumours. Reproducibility statistics for Ktrans, ve and IAUGC are comparable to those reported previously.

DCE-MRI has been investigated as a non-invasive appraiser of tumour vascularity for a number of tumour types, including breast and cervical carcinoma. We report the correlation between DCE-MRI kinetic parameters with the histological markers of tumour angiogenesis (CD31 and vascular endothelial growth factor (VEGF) immunostaining) in 15 patients with primary rectal cancer. There was poor correlation overall between T1- and T2*-weighted DCE-MRI kinetic parameters and tissue immunostaining except for Ktrans which correlated inversely with microvessel density (r = -0.65; p<0.05). These results underpin the need for further validation of DCE-MRI as a non-invasive indicator of rectal cancer angiogenesis.

VCT is a prototype CT-scanner using flat panel detectors for high resolution 3D-imaging. The purpose was to perform micro-angiography in tumour bearing mice and correlate results with MR-angiography and immunohistology. Scan protocols were optimised. Additionally, animals were examined with contrast-enhanced VCT and micro-MR-angiography. Non-invasive data were correlated with histology. VCT displays vessel-architecture of mice and tumours in excellent detail and plasticity. Draining tumour vessels are tracked from their outlet branching to irregular networks inside the tumours. In contrast to MRI, vessels of 100µm diameter are captured. VCT improves imaging of micro-vessels and is promising for studies on tumour angiogenesis.

High temporal resolution MRI of bolus transit of GdDTPA allows semi-quantitative analysis in terms of morphologic descriptors of dynamic enhancement but does not allow adequate vascular sampling to permit deconvolution with the arterial input function (AIF). We propose a method using dynamic contrast enhanced CT and micro-MR-angiography. Non-invasive data were correlated with histology. VCT displays vessel-architecture of mice and tumours in excellent detail and plasticity. Draining tumour vessels are tracked from their outlet branching to irregular networks inside the tumours. In contrast to MRI, vessels of 100µm diameter are captured. VCT improves imaging of micro-vessels and is promising for studies on tumour angiogenesis.
Dynamic susceptibility perfusion MRI was used to study microvascular leakage in 40 patients with malignant glioma or solitary brain metastasis prior to treatment. Peak height and percent recovery values were directly calculated from dynamic concentration curves to add specificity in characterizing microvascular changes over traditional blood volume measurements. Metastatic tumors exhibited a larger degree of microvascular leakage compared to GBMs despite the similar degree of vascularity between the two tumor types. The microvascular leakage within the peri-tumoral edema of metastatic tumors was greater than that of GBMs, suggesting altered capillary permeability within the vasogenic edema associated with metastatic brain tumors.

Dynamic perfusion weighted MR imaging was used to study tumor angiogenesis and microvascular leakage in 32 high grade glioma patients prior to treatment. Peak height and percent recovery of dynamic concentration curves were directly calculated in order to provide additional specificity in characterizing vascular changes over traditional rCBV measurements in high grade gliomas. Grade III gliomas were found to have different spatial patterns of these parameters compared to Grade IV gliomas.

Dynamic susceptibility perfusion MRI was used to study microvascular leakage in 40 patients with malignant glioma or solitary brain metastasis prior to treatment. Peak height and percent recovery values were directly calculated from dynamic concentration curves to add specificity in characterizing microvascular changes over traditional blood volume measurements. Metastatic tumors exhibited a larger degree of microvascular leakage compared to GBMs despite the similar degree of vascularity between the two tumor types. The microvascular leakage within the peri-tumoral edema of metastatic tumors was greater than that of GBMs, suggesting altered capillary permeability within the vasogenic edema associated with metastatic brain tumors.

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Diffusion tensor imaging (DTI), T2-weighted MRI and dynamic contrast-enhanced imaging were characterized the primary tumors and metastatic spreads in a breast cancer animal model. Small metastases (1-2 mm) in the bones area were detected by constructing maps of maximal enhancement. Analysis of the dynamic data according to a physiological model yielded parametric images of the vascular properties. Similar values for the above parameters were detected for the primary tumor and its metastases.

MRI of breast cancer metastasis in animal models is a challenge due to the small size and random distribution of the metastases. By applying high resolution MRI and dynamic contrast-enhanced imaging we characterized the primary tumors and metastatic spreads in a breast cancer animal model. Small metastases (1-2 mm) in the bones area were detected by constructing maps of maximal enhancement. Analysis of the dynamic data according to a physiological model yielded parametric images of the vascular properties. Similar values for the above parameters were detected for the primary tumor and its metastases.

The aim of this study is to characterize the tumoral tissular heterogeneity in a mouse breast tumor model by associating a non-specific and a rapid-clearance-blood-pool contrast agents in a contrast-enhanced dynamic MRI protocol. Distinguishing the different components requires a very high spatial resolution which is provided on a conventional body 1.5 T MRI unit by a High-Temperature Superconducting (HTS) surface coil. HES histology is used as the reference method. This study shows that conjunction of very high spatial resolution (isotropic 60 µm voxels) with quantitative kinetic features is of great potential for tumor characterization.

Diffusion tensor imaging (DTI), T2-weighted MRI and contrast enhanced (CE) MRI has been applied to study implanted rat brain gliomas to determine whether maps of diffusion, diffusion anisotropy, and contrast enhancement demonstrate similar or differential regions of tissue abnormality. Imaging was carried out prior to implantation and twice during tumor growth. When tumors are small, there is a significant decrease in diffusion anisotropy that corresponds to the region of enhancement measured by CE-MRI. As tumors grow, a more complicated relationship between anisotropy change and contrast enhancement is observed where some anisotropy persists in the regions of enhancement.

RCAS/tv-a technology provides a promising new platform for development of tissue- and oncogenic pathway-specific mouse tumor models. We characterized tumor appearance, growth and heterogeneity using high field T2-weighted, contrast-enhanced-T1-weighted, and diffusion MRI in a mouse that expresses tv-a under the control of the nestin promoter expressed in glial-progenitors (Ntv-a mouse). Tumors grew rapidly (2 week doubling time) and invasively, invading one or both ventricles. The MRI-measured tumor characteristics were very similar to those measured clinically in oligodendroglioma, with late stage tumors showing contrast-enhancing regions typical of malignant tissue, which was verified by histology.
13:41 **1986. A Comparison of MRI Based Electrical Impedance Imaging and Contrast Enhanced MRI of Tumors**

L. Tugan Muftuler\(^1\), Mark Hamamura\(^1\), Ozlem Birgul\(^1\), Orhan Nalcioglu\(^1\)

\(^1\)University of California, Irvine, California, USA

Recently, we reported sensitivity and spatial resolution of MRI based Electrical Impedance Imaging. In this study, we collected MR-EIT images followed by contrast enhanced MRI to investigate the potential of MR-EIT in detection of malignant tumors. Impedance images were obtained using a pulse sequence that is sensitive to perturbations in magnetic flux density that are induced by the electrical currents applied to the animal. Unlike previous methods, our method does not require rotation of the animal in the magnet. Significant correlation was observed between MR-EIT and contrast-enhanced images, both detecting multiple tumor foci around the abdomen of the animal.


Paul Stephen Tofts\(^1\), Chris Edward Benton\(^1\), Dan J. Tozer\(^1\), H Rolf Jäger\(^1\), Adam Waldman\(^1\), Jeremy H. Rees\(^1\)

\(^1\)University College London, London, UK

An objective methodology for quantifying Gd enhancement in gliomas is presented. 3D T1-w images are collected before and after injection of double dose Gd, then registered and subtracted to form maps of percentage signal enhancement (%E). Tumour outlines on FLAIR images are transferred to these maps. 30 subjects have been scanned every 6 months for up to 3 years. Histograms of %E show distinct differences between transformers and non-transformers; transformers have lower peak height, and a greater fraction of the tumour volume is in the increased right-hand tail of the histogram. Combined with other measures, we hope to predict transformation.

**DCE-MRI in Response to Anti-Cancer Therapy**

Room 509  Tuesday 13:30 - 15:30


J. James Stirling\(^1\), Linda A. Culver\(^1\), N. Jane Taylor\(^1\), Anwar R. Padhani\(^1\)

\(^1\)Mount Vernon Hospital, Northwood, Middlesex, UK

Multi-parameter DCE-MRI research protocols are complex and demanding imaging procedures. Non-diagnostic examinations can be minimised with careful attention to the recruitment of patients and lesions and by a well-designed imaging protocol. Adequate communication prior to and during examinations helps minimise failures. Consistency of patient and coil placement and contrast medium injection has to be ensured. Adequate documentation of imaging procedures minimises discrepancies between serial examinations. An ongoing quality assurance program enables drifts in signal and contrast to noise ratios to be detected and corrected.


Anwar R. Padhani\(^1\), N. Jane Taylor\(^1\), Katharine J. Lankester\(^1\), Mei-Lin W. Ah-See\(^1\), Gary Atkin\(^1\), Dawn M. Carnell\(^1\), J. James Stirling\(^1\), Robert Glynn-Jones\(^1\), Andreas Makris\(^1\), Peter J. Hoskin\(^1\), James A. D'Arcy\(^2\), Martin O. Leach\(^2\), Gordon J.S. Rustin\(^1\)

\(^1\)Mount Vernon Hospital, Northwood, Middlesex, UK; \(^2\)Institute of Cancer Research, Sutton, Surrey, UK

Efficacy of antivascular treatment varies between tumour types and probably relates to the state of angiogenesis and vasculature maturation. Non-invasive characterization of the angiogenic state of tumours may allow rational selection of such treatments. We report distinct differences in functional vascular status of four malignant human adenocarcinomas examined by multi-parametric quantitative dynamic contrast enhanced MRI (DCE-MRI). Rectal cancers were noticeably different in the proportion of enhancing modelling failures, Ktrans and maximum [Gd-DTPA] (p=0.001). Ovarian cancer had the lowest \(K^{\text{c}}\) and \(v_e\) but not of \(rBV\) or \(rBF\). These differences may be of importance when evaluating the efficacy of antiangiogenic/vascular targeting drugs.


Alexandre Coimbra\(^1\), Denise Welsh\(^1\), Bin Shi\(^1\), Susan Hill\(^1\), Laura Sepp-Lorenzino\(^1\), Donald Williams\(^1\)

\(^1\)Merck Research Laboratories, West Point, Pennsylvania, USA

Anti-angiogenic agents, such as KDR kinase inhibitors (KDRi) offer a promising way of inhibiting tumor growth. Dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) is used for measurement of vascular permeability in tumors. The present study has two main goals. Firstly, to evaluate the acute effects of an experimental KDRi in an orthotopic rat glioma model through various DCE-MRI scores related to tumor permeability. Secondly, this work aims at evaluating the different processing strategies for obtaining these scores. Four approaches were tested: initial slope of the uptake curve, initial area under the curve, and transfer constants from kinetic modeling approaches.
13:33 1991. Characterization of Intradermal Histamine-Induced Vascular Leak in Mice
Blanca E. Zauscher, Robert V. Mulkern, Andrea LaForme, Mark W. Kieran
1Massachusetts Institute of Technology, Cambridge, Massachusetts, USA; 2Children's Hospital, Boston, Massachusetts, USA; 3Dana-Farber Cancer Institute, Boston, Massachusetts, USA

In an effort to find a surrogate marker of anti-angiogenic drug activity, we investigated intradermal histamine-induced vascular leak and the possibility of using MRI to measure intradermal edema in mice. After Evan’s blue dye administration, histamine and saline intradermal injections were given to 5 mice. Subsequently, fat suppressed, T1-weighted images were obtained every 2 minutes during a 25-minute interval post Gd-DTPA administration. Volumes and intensity of fluid at injection sites were compared. The sides with histamine had a distinctly larger volume in all mice. Results suggest that MRI can be used to measure intradermal vascular leak.

1Mount Vernon Hospital, Northwood, Middlesex, UK; 2Institute of Cancer Research, Sutton, Surrey, UK; 3Luton and Dunstable Hospital, Luton, UK

For women being treated with neoadjuvant chemotherapy for primary breast cancer, the ability to identify early during treatment those who will fail to respond can enable the use of alternative therapies that may be more beneficial. Here, we report the results of a prospective study demonstrating that changes in DCE-MRI-derived semi-quantitative and quantitative vascular parameters following 2 cycles of neoadjuvant chemotherapy predict final clinico-pathological response to 6 cycles of treatment.

Martin Pickles, Martin Lowry, David Manton, Lindsay Turnbull
1University of Hull, Hull, UK

This study investigates whether quantitative DCE-MRI derived pharmacokinetic parameters can differentiate between responders and non-responders for breast cancer patients treated with neoadjuvant chemotherapy. The transfer constant (Ktrans), rate constant (Kep) and extracellular space (Ve) were calculated for a lesion encompassing ROI and a 3x3 pixel ‘hot-spot’ ROI at two time points – pre treatment and at the end of cycle 2 or 3. The results suggest that an early reduction in Ve and Ktrans increases the probability of response. Additionally, ‘hot-spot’ analysis increased the number of significant parameters from two for lesion ROI to five for ‘hot-spot’ analysis.

Michael C. Lee, Janine Lupo, Soonmee Cha, Susan M. Chang, Sarah J. Nelson
1University of California, San Francisco, California, USA

Dynamic susceptibility-contrast perfusion imaging was used to study the effect of ionizing radiation on healthy human brain tissue. Perfusion imaging was performed on 14 patients immediately before and after therapy, and two months post-therapy. The degree to which the contrast agent concentration recovered to pre-injection levels was quantified and taken as a measure of microvascular leakage. It was found that two months following radiotherapy, there was an inverse relationship between radiation dose and recovery in normal appearing brain tissue, suggesting that radiation damage to the microvasculature could be observed through perfusion imaging.

13:37 1995. The Steroid, Dexamethasone, Normalizes Brain Tumor Hemodynamics in a Rat Tumor Model as Indicated by DSC-MRI Perfusion Parameters
Christopher Chad Quarles, Doug Ward, Michael A. Badruddoja, Scott D. Rand, Hendrikus G.J. Krouwer, Kathleen M. Schmainda
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Using a combined GE/SE DSC perfusion method we evaluated the response of a rat brain tumor to 3mg/kg of dexamethasone, which is known to inhibit VEGF in the 9L tumor model. Mean untreated and treated tumor volume, GE and SE nCBF, nCBV, nMTT, and transit time distributions (TTDs) were compared. Dexamethasone significantly decreased tumor volume, nCBV and nMTT, while increasing nCBF and normalizing the TTDs. These results demonstrate how DSC perfusion methods can play a key role in evaluating response to therapy.
13:38 1996. Preclinical Evaluation of Anti-Angiogenic Agent Roche1 by Dynamic Contrast Enhanced MRI at 1.5T
M Muruganandham1, M Lupu1, JP Dyke2, C Matei1, B Higgins3, K Kolinsky1, M Bachynsky1, Grace Ju1,
JA Koutcher1
1Memorial Sloan-Kettering Cancer Center, New York, New York, USA; 2Weill Cornell Medical College, Comel University, New York, New York, USA; 3Hoffman-La Roche Inc., Nutley, New Jersey, USA

Anti-angiogenic effects of Roche-1, a novel tyrosine kinase receptor inhibitor, have been evaluated in H460a tumor model by DCE MRI. Tumor perfusion (initial slope of the time-intensity curve) and microvessel permeability (AKep) status were analyzed. The tumor-rim slope and AKep values were lower in Roche-1 treated tumors on day 7 compared to their baseline. Controls, treated with vehicle for Roche-1, showed no significant change. On day 7 post-treatment, Roche-1 inhibited tumor growth by 50% relative to the controls. ROI Selection for the kinetics analysis influences outcome of the results.

Thorsten Persige1, Lars Mattuzewski1, Alexander Wall1, Ralf Bieker1, Norbert Meier1, Torsten Kessler1, Walter Berdel1, Ralf Mesters1, Walter Heindel1, Christoph Bremer1
1University of Muenster, Muenster, Germany

The aim of this study was the evaluation of iron oxide enhanced MRI for non-invasive, early detection of the efficacy of anti-angiogenic tumor treatment. Fibrosarcoma bearing mice were injected with a vascular targeting agent (VTA) or saline and measured using a T2 weighted dual Echo-EPI sequence. After injection of the VTA a significant reduction of the vascular volume fraction and an approximate 80% decrease of AR2* in treated animals compared to controls was measured. In conclusion iron oxide enhanced MRI is a useful method for early non-invasive monitoring of tumor response of anti-angiogenic treatment.

13:40 1998. Value of Dynamic Contrast-Enhanced MRI (DCE-MRI) and Diffusion-Weighted MRI (DW-MRI) for the Monitoring of the Effect of a Vascular Targeting Agent on Rodent Tumors
Harriet C. Thoeny1, Frederik De Keyzer1, Vincent Vandecaveye1, Feng Chen1, Yicheng Ni1, Robert Hermans1, Guy Marchal1, Willy Landuyt1
1University Hospitals Leuven, Leuven, Belgium

DW-MRI and DCE-MRI provide similar information on the effect of vascular targeting compounds. The use of low and high b-values for the calculation of the ADC allows to separate the influence of perfusion and diffusion. The ADChigh approximates true diffusion, whereas the ADClow reflects both diffusion and perfusion. Therefore, the difference between ADClow and ADChigh approximates perfusion. This perfusion is paralleled with the k value provided by DCE-MRI. The ADChigh gives information about the integrity of the underlying tumor cells and can therefore be used to differentiate viable and necrotic tissue.

13:41 1999. Monitoring the Effect of a Vascular Targeting Agent on Rhabdomyosarcomas in Rats by Diffusion-Weighted MRI
Harriet C. Thoeny1, Frederik De Keyzer1, Feng Chen1, Yicheng Ni1, Ronald R. Peeters1, Eric K. Verbeeken1, Hilde Bosmans1, Guy Marchal1, Willy Landuyt1, Robert Hermans1
1University Hospitals Leuven, Leuven, Belgium

The acute (1 and 6 hours) and late (2 and 9 days) effects of the antivascular drug (Combretastatin) on subcutaneously implanted rhabdomyosarcomas in rats were assessed by pre- and post-contrast T1-weighted spin-echo and diffusion-weighted echo-planar MRI. DW-MRI allows to assess intratumoral changes noninvasively after administration of a vascular targeting agent. In contrast to conventional MRI, DW-MRI provides more accurate information for differentiating between viable and necrotic tumor tissue. Therefore, it is a promising tool for monitoring the effects of tumor blood vessel-directed agents.

Christopher Chad Quarles1, Scott D. Rand1, Hendrikus G.J. Krouwer1, Kathleen M. Schmainda1
1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Using a combined GE/SE DSC perfusion method we evaluated the response of a rat brain tumor to 20 mg/kg and 40 mg/kg of the antiangiogenic drug SU11657. Mean untreated and treated tumor volume, GE and SE nCBF, nCBV, nMTT, transit time distributions (TTDs) and the ratio, AR2*/AR2 (a measure of mean vessel diameter (mVD)), were compared. A 20 mg/kg dose significantly decreased the mVD, while the 40 mg/kg significantly decreased volume, mVD, nCBV and nMTT, while increasing nCBF and normalizing the TTDs. These results demonstrate how DSC perfusion methods can play a key role in evaluating response to therapy.
MR of Cancer: Metabolomics and Therapy Response

Room 509  Wednesday 13:30 - 15:30

13:30  2001. Caveolae Mediated Labeling of Fibroblasts for Tracking by MRI
Dorit Granot1, Maria Shatz1, Hagit Dafni1, Leoni A. Kunz-Schughart1, Michal Neeman1
1Weizmann Institute of Science, Rehovot, Israel; 2University of Regensburg, Regensburg, Germany

Fibroblasts at the tumor-host interface can differentiate into myofibroblasts and pericytes, thereby guiding and stabilizing endothelial sprouts. After intravenous administration of biotin-BSA-GdDTPA33-(FAM), tumor associated fibroblasts showed accumulation of contrast material in intracellular granules. Thus we evaluated the use of this contrast material for in vitro labeling and tracking of fibroblasts. Fluorescence microscopy demonstrated internalization of contrast material and MRI revealed significant increase in R1 of labeled fibroblasts, which maintained for two weeks in culture. Uptake was suppressed by nystatin, suggesting caveolae mediated endocytosis. This study shows feasibility of labeling of fibroblasts and may allow in-vivo tracking of tumor associated fibroblasts.

13:31  2002. Validation and Diagnostic Accuracy of Quantitative Measurement of Tumor Characteristics by MRI, PET and Histology of Mice Tumor
Rakesh Sharma1, Peter Esser2, Jose Katz2
1Columbia University, New York, New York, USA

MRI and PET integrated method may provide the both morphological status and metabolic status of tumor growth by tumor physiology and tumor glucose uptake. PET/MRI serves the purpose to identify and quantify the status of apoptosis in prostate tumor.

Franklyn Arron Howe1, Roger Springett2, Simon P. Robinson1, James P. Connelly1, John R. Griffiths1
1St George's Hospital Medical School, London, UK; 2Dartmouth Medical School, Hanover, New Hampshire, USA

Tumor vascularity and oxygenation can be interrogated with MRI via R2* and its change with carbogen breathing because of its dependendence on tissue deoxyhemoglobin (Hb) concentration. Near Infrared Spectroscopy can also determine tissue Hb concentration and Hb changes in response to a vascular challenge. We have compared data obtained in rodent tumors by MRI and NIRS and made a theoretical analysis that relates the results to the oxygen dissociation curve. Our data suggests that R2* images can provide an estimate of the change in tumor blood pO2 with a carbogen challenge and may provide an index of tumor oxygenation status.

Mengna Xia1, Vikram D. Kodibagkar2, Anca Constantinescu2, Yueqing Gu1, Hanli Liu1, Ralph P. Mason2
1University of Texas at Arlington, Arlington, Texas, USA; 2UT Southwestern Medical Center at Dallas, Dallas, Texas, USA

We measured breast tumor oxygenation parameters in rats simultaneously by MRI and NIRS during respiratory challenge with oxygen or carbogen. There was a strong correlation between the rate of tissue response (pO2) measured by MRI and the fast component of [HbO2] measured by NIRS which represents perfusion. These studies demonstrate the feasibility of conducting simultaneous NIRS and MRI oximetry.

13:34  2005. Further Validation of MR Oximetry as a Useful Prognostic Indicator of Tumor Radiation Response
Vincent A. Bourke1, Joseph Gilio1, Lan Jiang1, Anca Constantinescu1, Dawen Zhao1, Vikram Kodibagkar1, Ralph P. Mason1
1UT Southwestern Medical Center, Dallas, Texas, USA

It has long been recognized that pO2 is one of the factors that may modulate the efficay of radiation therapy, and may play a role in a tumors progression to more malignant phenotypes. Accordingly, the ability to dynamically sample intratumoral oxygenation tension may have significant potential as an independent prognostic indicator of therapeutic outcome. Here we provide further in-vivo validation of the recently developed MR Oximetry technique called FREDOM (Flurocarbon Relaxometry using Echo planar imaging for Dynamic Oxygen Mapping).

13:35  2006. Sodium MRI of Chemotherapeutic Response in a 9L Rat Glioma Model
Victor D. Schepkin1, Brian D. Ross1, Thomas L. Chenevert1, Jadranka Stojanovska1, Mahesh Kumar1
1University of Michigan Medical School, Ann Arbor, Michigan, USA

This study investigates the relationship between changes in the Na signal and water diffusion following cancer therapy using a brain tumor model with the objective to develop early markers of response. Following a single dose of a chemotherapeutic agent, both Na MRI and proton diffusion mapping were performed for a 9L tumor in a rat brain. An increase in the tumor Na content and a decrease of bound Na relative to an untreated tumor was detected which correlates with a known predictive increase of tumor diffusion indicating a positive tumor response.
13:36 2007. Changes in the Tumor Microenvironment Early after Treatment with the Anti-Angiogenic Agent Thalidomide
Réginald Ansiaux1, Christine Baudelet1, Bénédicte Jordan1, Nelson Beghein1, Olivier Feron1,
Vincent Grégoire1, Bernard Gallez1
1Catholic University of Louvain, Brussels, Belgium

The tumor microenvironment parameters fluctuate during anti-angiogenic treatment. This is of crucial importance to determine the optimal time scale to combine treatments. At the early stage after starting the treatment with thalidomide, an increase in pO2 was observed due to a transient improvement of perfusion. This could be the consequence of the IFP decrease resulting from the immature vessels. We demonstrated a better radiosensitivity of tumors at this critical step of the thalidomide treatment.

Lisa J. Wilmes1, Ka-Loh Li2, Jessica Gibbs1, Lisa M. Fleming1, Dmitri Kirpotin2, Daryl Drummond2,
John W. Park1, Nola M. Hylton1
1University of California San Francisco, San Francisco, California, USA; 2Hermes Biosciences, South San Francisco, California, USA

The pharmacokinetics and distribution of gadolinium (Gd) encapsulating ‘water-impermeable’ liposomes, both anti-HER2 targeted and non-targeted, were studied in a HER2 over-expressing human breast cancer xenograft model using MRI. Tumor enhancement data were analyzed using a unidirectional two-compartment model, based on the assumption that within 24 hours after injection of Gd-liposomes, reflux of the tracer from interstitial water to plasma is negligible. A higher apparent endothelial transfer coefficient (Ktrans) was observed for anti-HER2 targeted liposomes than for non-targeted, indicating an increase in T1 relaxivity that may be reflective of disruption of the targeted liposomes upon cellular internalization.

Erica Corinne Henning1, Chieko Azuma2, Christopher H. Sotak1, Karl G. Helmer1
1Worcester Polytechnic Institute, Worcester, Massachusetts, USA; 2Tufts University School of Veterinary Medicine, North Grafton, Massachusetts, USA

We report on a single-dose (1000cGy) radiotherapy study using RIF-1 tumors in which multispectral (MS) analysis using the k-means (KM) clustering algorithm was used to identify multiple compartments in both viable and necrotic tissue. The goal is to identify sub-compartments in each tissue type to characterize tissue that includes heterogeneity. ADC and T2 parameter maps were used as MS parameters. The total viable volume fraction decreased out to day-4 post-irradiation, with a concomitant increase in the total necrotic volume fraction. Mean MR parameter values for each cluster indicate that regions of significant heterogeneity exist in both viable and necrotic tissue.

13:39 2010. MR Imaging of Cerebral Radiation Injury Following Carbon Ion Radiotherapy for Head and Neck Tumors
Riwa Kishimoto1, Susumu Kandatsu1, Shouhei Hanaoka1, Takayuki Obata1, Jun-etsu Mizoe1, Hirohiko Tsujii1
1National Institute of Radiological Science, Chiba, Japan

Characteristic MR findings in the radiation field are helpful to differentiate cerebral radiation injury from invasion or metastasis of the primary tumor. Radiation injury was demonstrated as high intensity area on T2-weighted image and focal contrast enhancement within radiation field, especially in full dose area. Non-enhanced area was then spread gradually in contrast-enhanced area and cystic lesion developed occasionally. The mean interval between irradiation and presentation was 27 months. Two third of these cases with radiation injury following carbon ion radiotherapy did not require any treatment. In 5 cases (17%), radiation injury was reduced in size without any treatment.

13:40 2011. Transrectal Prostate Biopsy and Fiducial Marker Placement in a Standard 1.5T MRI Scanner
Robert C. Susil1, Cynthia Menard1, Axel Krieger1, Jonathan A. Coleman1, Kevin Camphausen1,
Peter Choyke2, Karen Ullman2, Sharon Smith2, Gabor Fichtinger1, Louis L. Whitcomb1,
C Norman Coleman1, Ergin Atalar2
1Johns Hopkins University, Baltimore, Maryland, USA; 2National Institutes of Health, Bethesda, Maryland, USA

The purpose of this study is to investigate the safety and accuracy of a novel ‘APT-MRI’ system (Access to Prostate Tissue under MRI-guidance) that provides transrectal needle access to the prostate while a patient is imaged inside of a ‘closed’ 1.5T scanner, which previously has not been possible. In a series of 6 clinical procedures, a mean needle placement accuracy of 1.8 mm was achieved. The system was used for both fiducial marker placement and biopsy in prostate cancer patients.
13:41 2012. Validation and Comparison of Pre- and Intraoperative Repeated Image Segmentation in MRI-Guided Brachytherapy Based on Spatial Overlap Statistics

Kelly H. Zou1, Aditya Bharatha2, Nobuhiko Hata1, Masanori Hirose2, Steven J. Haker2, Robert A. Cormack1, William M. Wells1, Anthony D'Amico1, Ron Kikinis1, Ferenc A. Jolesz1, Clare M. C. Tempany1
1Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; 2University of Toronto Medical School, Toronto, Ontario, Canada; 1University of Tokyo, Tokyo, Japan; 3Showa University, Tokyo, Japan

The quality of segmentations has a direct impact on detection and target definition in MR-guided prostate brachytherapy. Ten brachytherapy cases underwent both preoperative 1.5T and intraoperative 0.5T MR imaging. In each case, 5 repeated manual segmentations of the prostate peripheral zone were performed, separately on both pre- and intraoperative images. The reproducibility of segmenting these MR images was measured and compared using the Dice similarity coefficient. Repeated segmentations yielded satisfactory reproducibility, which was significantly higher based on 1.5T preoperative images. No significant difference existed between segmentation pairs. A learning curve was not observed. However, case difference was significant.

MR Spectroscopy of Cells, Body Fluids, and Others

Room 510  Tuesday 13:30 - 15:30

13:30 2013. Detection of 1,2-Propanediol in Rat Brain Microdialysates by High Resolution NMR Spectroscopy

Jingna Wei1, Edward L. Ezell1, Michael J. Quast1
1University of Texas Medical Branch, Galveston, Texas, USA

We used high resolution (9.4 T and 17.6 T) NMR spectroscopy to study rat brain microdialysates at baseline, during periods of middle cerebral artery occlusion (MCAO) and reperfusion. Relatively high levels (~100 uM) of 1,2-propanedol (1,2-PD) were detected in all dialysates. During MCAO and reperfusion periods 1,2-PD levels decreased and lactate levels increased significantly. While the source of brain 1,2-PD is not clear, it appears to be a significant and consumable component of rat brain extracellular fluid.


Anthony Mancuso1, Nancy Jean Beardsley1
1University of Pennsylvania, Philadelphia, Pennsylvania, USA

Cultured BHC9 insulinomas were examined with 13C NMR spectroscopy during infusion of [1,6-13C2] glucose. The cells were immobilized on the surface of microcarriers with the aid of a recombinant fibronectin. The microcarriers were used in a tightly packed bed and approximately 8x10^6 cells were sustained in the sensitive volume of the spectrometer. The 13C results indicated that stimuli known to increase insulin secretion also increased the flux of glucose-derived carbon into the TCA cycle. The results are consistent with the "fuels hypothesis" for beta cell function, which purports that insulin secretion is mechanistically linked with catabolic processes.

13:32 2015. Potential of In-Vitro Proton MRS of Seminal Plasma in the Diagnosis of Male Infertility Diseases

P. K. Chaturvedi1, Uma Sharma1, A. Kumar1, N. R. Jagannathan1
1All India Institute of Medical Sciences, New Delhi, Delhi, India

Using various one- and two-dimensional NMR methodologies, the determination of concentration of the metabolites present in human seminal plasma of patients with oligoasthenozoospermia (OAT), asthenoteratozoospermia (AT) and teratozoospermia (T) were carried out. Significantly higher concentration of Lac and Glc were observed in patients of AT group compared to patients of OAT and T groups, while significantly lower concentration of Cit was observed in patients of T group compared to both AT and OAT groups. Our results demonstrate the utility of in-vitro proton MRS as a technically simple and economical tool in the clinical diagnosis of male infertility diseases.

13:33 2016. 7Li MR Studies of Codrug Effects on Plasma and RBC Lithium of Rats Under Li Prophylaxis

Subbaraya Ramaprasad1, Elzbieta Ripp1
1University of Nebraska Medical Center, Omaha, Nebraska, USA

We are using MR to study the lithium in plasma and RBC of rats when a codrug is administered to rats under lithium prophylaxis. This study design consists of coadministration of Li with fluoxetine (SSRI antidepressant), Citalopram, (SSRI antidepressant with a different chemical structure), fluphenazine (antipsychotic), clozapine (atypical antipsychotic) and, valproic acid (anticonvulsant and antiepileptic) drugs. Here we report the results on lithium in the RBC (intra) and plasma (extracellular) compartments by 7Li MR technique in the presence of a shift reagent. The differential effect of co-drug on RBC and plasma Li concentrations are discussed.
MRS Signals Can Monitor Cell Damage as Well as Apoptosis Induced by Gamma Rays and Proton Beams on Tumor Cells

Sveva Grande¹, Anna Maria Luciani², Alessandra Palma¹, Antonella Rosi¹, Vincenza Vitili¹, P. A. Lojacocono², V. I. Patti², L. M. Valastro², Laura Guidoni¹

¹Istituto Superiore di Sanità, Roma, Italy; ²INFN-Laboratori Nazionali del Sud, Catania, Italy

The analysis of the metabolic events induced by irradiation can be of great help in elucidating different mechanisms of tumor cell death. In this study, MRS was applied to the examination of lipid and lipid metabolite signals in cultured tumor MCF-7 cells after irradiation by gamma rays or proton beams. Data from literature indicates that irradiation of MCF-7 cells induces cell death mostly by apoptosis. Identification of MR signals related to metabolic effects or to the kind of cell death may result in spectroscopic markers that can be used to detect the effects of radio-therapeutical treatments in vivo.

Differences and Similarities in Brain Metabolites Observed by High Resolution Magic Angle Spinning ¹H NMR of Intact Tissue and Solution ¹H NMR of Tissue Extracts from a Primate Model of neuroAIDS

Eva-Maria Ratai¹, Susan V. Westmoreland², Margaret R. Lentz¹, Jane B. Greco¹, Sarah J. Pilkenton¹, Robert A. Fuller¹, John P. Kim¹, Julian He¹, Prabhat K. Sehgal², Leo Ling Cheng¹, Ramon Gilberto González³

¹Massachusetts General Hospital NMR Center, Charlestown, Massachusetts, USA; ²New England Primate Research Center, Southborough, Massachusetts, USA; ³Massachusetts General Hospital, Boston, Massachusetts, USA

The objective of this study was to compare ex vivo ¹H HRMAS MR spectra of intact tissue to those spectra obtained by solution ¹H NMR of brain extracts of the same sample. Sixteen brain tissue samples from both cortex and putamen were evaluated by comparing brain metabolite quantities of N-acetylaspartate, choline-containing compounds, myo-inositol, creatine, lactate, glutamate, and acetate. The ratios of the individual metabolites to creatine were calculated. Linear regression analysis revealed significant correlations between the two methods. However, the pattern in the relationship between tissue HRMAS and extract solution NMR for Cho/Cr was distinct from the other metabolites.

Repeated Doses of Temozolomide Cause Repeated Increases in Nucleoside Triphosphates in Cultured Human Glioma Cells

Aizhi Zhu¹, Nancy Jean Beardsley¹, Matthew Milkevitch¹, Stephen Pickup¹, Edward James Delikatny¹, Anthony Mancuso¹

¹University of Pennsylvania, Philadelphia, Pennsylvania, USA

The effects of temozolomide on cultured human glioma cells were examined with 3¹P NMR spectroscopy. Cells were examined in an artificial tumor composed of collagen and polystyrene microcarriers. The drug was found to increase NTP levels within minutes of administration. An increase in NTP was also observed after a second treatment, following a 24-hr delay between the doses. No other significant changes in ¹H spectra were observed. The results suggest that ¹H NMR may be useful for detected drug delivery to brain tumors.

Utility of In-Vitro Proton NMR of Cerebrospinal Fluid in the Diagnosis of Patients with Spina Bifida

Uma Sharma¹, K. Pal¹, D. K. Gupta¹, N. R. Jagannathan¹

¹All India Institute of Medical Sciences, New Delhi, Delhi, India

The metabolic profile of CSF of patients with spina bifida was investigated using in-vitro proton NMR methods. The concentration of lactate (Lac), choline (Cho), glycerophosphocholine (GPC), acetate (Ace) and alanine (Ala) were found to be statistically significantly higher in CSF of spina bifida patients compared to normal subjects. The higher concentration of Lac may be indicative of ischemic state and anaerobic metabolic processes in neurons, while higher concentration of GPC and Cho may be attributed to disruption of neuronal membrane in patients of spina bifida.

Metabolic Characterization of Asymptomatic Sickle Cell Disease Patients Using ¹H Magnetic Resonance Spectroscopy

Eloy D. Alvarez-Guerra¹, Jorge Losada-Gómez¹, Harold G. Parker², Jimmy D. Bell³

¹Universidad de Oriente, Santiago, Cuba; ²University College London, London, UK; ³Hammersmith Hospital, Imperial College London, London, UK

High resolution ¹H NMR spectroscopy of whole blood extracts at 500 MHz from patients with asymptomatic sickle cell disease (SCD) were analysed and compared with controls. A number of metabolites including valine, alanine, acetate, 3-hydroxybutyrate and N-methyl containing compounds were found to be significantly different between the two groups. Principal component analysis was also carried out and the two groups formed separate clusters. High resolution NMR spectroscopy may be important tool in assessing asymptomatic SCD patients as well as patients in crisis.
13:39  

**Cardiac and Renal Energy Metabolism following Intestinal Ischemia-Reperfusion: In Vitro \(^1\)H and \(^3\)P Magnetic Resonance Spectroscopy Study**

Paisarn Vejchapipat\(^1\), Harry G. Parkes\(^1\), David G. Gadian\(^2\), Simona Vinardi\(^2\), Soottiporn Chittmittrapap\(^1\), Agostino Pierro\(^2\)

\(^1\)Chulalongkorn University, Bangkok, Thailand; \(^2\)Institute of Child Health, London, UK

The study was designed to investigate cardiac and renal metabolism after intestinal ischemia-reperfusion (IR). Two groups of rats were studied: sham operation and intestinal IR. In vitro \(^1\)H and \(^3\)P MRS of intestinal, cardiac, and renal tissue extracts were performed using 11.7 T MR spectrometer. Phosphocreatine, ATP, inorganic phosphate, glucose, alanine and lactate were analyzed. Unpaired t-tests were used. Intestinal IR caused intestinal energy failure. Heart and kidneys respond to intestinal IR differently. Increases in renal alanine and lactate were revealed, suggestive of renal ischemia after intestinal IR. However, there was no change in cardiac phosphoenergetics following intestinal IR.

13:40  

**\(^1\)H-MR-Spectroscopy of Swine Brain to Investigate Postmortem Decomposition Processes**

Reinhard Rzanny\(^1\), Jürgen R. Reichenbach\(^1\), Sibylle Banaschak\(^1\), Alexander Gussew\(^1\), Annelies Klein\(^1\), Werner A. Kaiser\(^1\)

\(^1\)Friedrich-Schiller-University, Jena, Thüringen, Germany

Five swine heads were investigated with 1H-MRS in a clinical whole body scanner over a post mortem interval (PMI) of up to 3 weeks. Decomposition processes of brain tissue could be monitored by decreasing intensities of the typical resonances observed in healthy brain, such as NAA, creatine and choline, and by increasing intensities of degradation products, like acetate, succinate and free trimethylammonium. Assuming small individual variations in brain tissue composition the results indicate that in situ MRS measurements can identify biochemical markers that can be used for non-destructive estimations of the PMI in forensic medicine.

13:41  

**NMR Studies of Amniotic Fluid in Human Fetal Urogenital Tract Obstruction**

Harold G. Parkes\(^1\), Joseph E. Kidane\(^2\), Lyn Chitty\(^1\), Vincent Tse\(^1\), Paul J D Winyard\(^2\)

\(^1\)University College London, London, UK; \(^2\)Birkbeck College, London, UK

High resolution NMR studies at 500 MHz were carried out on amniotic fluid from patients presenting with a fetus that was showing signs of abnormal kidney development due to congenital urinary outflow obstruction. A number of endogenous metabolites, for example, histidine, tyrosine, acetate alanine, glycine, trimethyl N-oxide (TMAO) and pyruvate were quantified and analysed using principal component analysis. TMAO, hippurate and pyruvate were found to be elevated and histidine, tyrosine, acetate and alanine were found to be decreased in the amniotic fluid associated with fetuses presenting with kidney damage.

13:42  

**Human Saliva \(^1\)H-NMR Study Characterizing Macromolecule/Metabolites Interaction**

Seizo Takahashi\(^1\), Keiko Imura\(^1\), Kozue Shirashi\(^1\), Yukiharu Yamaguchi\(^1\), Takashi Ogino\(^1\)

\(^1\)Japan Women's University, Tokyo, Japan; \(^1\)Pfizer Japan Inc., Tokyo, Japan; \(^1\)National Institute of Neuroscience, Tokyo, Japan

High-resolution 1H-NMR spectra of fresh and intact saliva samples were measured. The 1H-NMR spectral intensities of small molecules increased with time under the presence of macromolecules. However, the change in signal intensities remained within a reasonable range for 4 hours after sampling. The pH titration revealed that the Hill coefficients were less than 0.5, which suggested that the observed small molecules make a rapid chemical exchange between bound and free states in solution. The presence of dynamic magnetic transfer to macromolecules was verified observing the double-quantum filtered spectra. The simultaneous observation of single and double quantum spectra were also explored.

13:43  

**Media-Influenced Secretory and \(^13\)C Isotopomer Behavior of Insulinoma Cells**

Nicholas Edward Simpson\(^1\), Nata Khokhlova\(^1\), Nata. Oca Cossio\(^1\), Ioannis Constantinidis\(^1\)

\(^1\)University of Florida, Gainesville, Florida, USA

Understanding the mechanism of insulin secretion in physiologically relevant media is critical. In this study the effect of incubation medium composition on insulin secretion, glucose consumption and the extract isotopomer pattern of 13C-labeled resonances was investigated in four insulinoma cell lines. Incubation compositions used in this study were: PBS; media without sera; and media fully supplemented with sera, each containing uniformly labeled 13C-glucose. Our data show significant changes in metabolic (glucose consumption and lactate production) and secretory (insulin secretion) rates as well as the alterations in isotopomer patterns of 13C resonances as a function of medium complexity.
Cancer MR Spectroscopy of Model Systems

Room 510       Wednesday 13:30 - 15:30

13:30 2027. F utile Cycling of Lactate and Protons Through the Plasma Membrane of C6 Glioma Cells as Detected by 2H-13C NMR
Tiago Brandao Rodrigues1, Heather L. Gray1, Marina Benito1, Susana Garrido1, Paloma Ballesteros2, Sebastian Cerdan1
1CSIC, Madrid, Spain; 2UNED, Madrid, Spain

We present a novel 2H-13C NMR method to evaluate lactate recycling through the plasma membrane MCT1 transporter of C6 glioma cells. The method uses (3-13C) or (U-13C) lactate as substrates, detecting the recycled lactate molecules because they incorporate a deuteron in C2 in the lactate dehydrogenase equilibrium. (3-13C, 2-2H) and (U-13C, 2-2H) lactate are easily distinguished by high resolution 13C NMR from non deuterated lactate (21.0 ppm) because C2 deuterated lactates originate -0.1 ppm vicinally shifted C3 resonances. During an incubation period of 48h, essentially all lactate molecules in the medium are recycled through the MCT1 transporter.

13:31 2028. Choline Kinase Knock-Down in Breast Cancer Cells using RNA Interference is Associated with an Increase in Intracellular Lipid Droplets and Triacylglycerides
Kristine Glunde1, Venu Raman1, Noriko Mori1, Yelena Mironchik1, Zaver M. Bhujwalla1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Increased choline kinase (ChK) expression and activity are associated with increased malignancy, and may be a major factor for the elevated NMR-detectable levels of phosphocholine (PC) and total choline (tCho) in breast cancer cells. To test this hypothesis, we used small interfering RNA against ChK (siRNA-chk) to specifically knock down ChK expression. ChK activity and its downstream effects were monitored by 1H NMR spectroscopy and fluorescence microscopy. siRNA-chk treatment significantly reduced PC and tCho levels in breast cancer cells, but not in human mammary epithelial cells. The knock-down of ChK increased the formation of intracellular triacylglyceride-containing lipid droplets indicating differentiation.

13:32 2029. Correlation between Choline Kinase mRNA and 1H MRS-Detectable Choline Metabolite Levels in Stable Choline Kinase Knock-Down Clones of a Human Breast Cancer Cell Line
Kristine Glunde1, Venu Raman1, Zaver M. Bhujwalla1
1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Elevated phosphocholine (PC) and total choline (tCho) levels in breast cancer cells, frequently detected by 1H MRSI, may be caused by an increased expression of choline kinase (Chk). Clones of human breast cancer cells were generated that stably express small interfering RNA to specifically knock down Chk mRNA levels. Chk mRNA, PC, and tCho levels were monitored in several Chk knock-down clones by quantitative real-time reverse transcription-polymerase chain reaction (Q-RT-PCR) analysis and 1H MR spectroscopy. A direct correlation between Chk mRNA level and PC and tCho concentration was observed.

Noriko Mori1, Kristine Glunde1, Venu Raman1, Zaver M. Bhujwalla1
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Vascular endothelial growth factor (VEGF) plays an important role in tumor angiogenesis and the response of tumors to hypoxia. To investigate the role of VEGF in cancer cells, we generated stable clones of VEGF-A overexpressing human MDA-MB-231 breast cancer cells. 1H and 31P NMR spectroscopy was employed to determine the effects of VEGF-A overexpression on choline phospholipid metabolism. MDA-MB-231 tumors derived from VEGF-A overexpressing cells exhibited a significant increase in phosphocholine and a decrease in glycerophosphocholine levels, compared to tumors derived from control empty-vector transfected cells. The cellular total choline concentration was not affected by VEGF-A overexpression.

13:34 2031. 19F MR Quantitation of Fluorine Labeled Photosensitizers in Tumors and Normal Tissue
Subbaraya Ramaprasad1, Elzbieta Ripp1, Jiaxiong Pi1, Shantaram Joshi1, Joseph Missert2, Mahabeer P. Dobhal2, Ravindra K. Pandey2
1University of Nebraska Medical Center, Omaha, Nebraska, USA; 2Roswell Park Cancer Institute, Buffalo, New York, USA

Photodynamic therapy (PDT) is a cancer treatment modality that combines light sensitive drug and lasers. Monitoring photosensitizers (PS) in the tumor and normal tissue is helpful in the development of new photosensitizers. Syntheses of photosensitizers labeled with Fluorine-19 offer the advantage of noninvasive assessment of the photosensitizer concentration in a living subject. The assessment of the same in the skin and underlying muscle has the potential to provide information about the cutaneous toxicity of PS. Here we present the construction of pharmacokinetic profiles of two new photosensitizers in the tumor and muscle and their utility in PDT studies.
Elevated total choline-containing compounds (tCho) in malignancies have been postulated to reflect proliferation of neoplastic cells. Accordingly, changes in tCho following chemotherapy may be indicative of an anti-proliferative response. In this study, in vivo 1H MRS was used to monitor changes in tCho during treatment with doxorubicin in mice that simultaneously harbored both wild-type and doxorubicin-resistant MCF-7 tumors. As compared with baseline levels, 24 hours after drug administration, tCho/water ratio was significantly reduced in sensitive wild-type tumors, while resistant tumors showed a smaller non-significant change. This supports the hypothesis that early changes in tumor tCho levels can predict chemo-sensitivity.

**13:36 2033. The Response of RIF-1 Fibrosarcomas to the Vascular Targeting Drug ZD6126 Assessed by In Vivo 1H MRS**

Basetti Madhu1, John R. Griffiths1, Anderson J. Ryan2, John C. Waterton1, Simon P. Robinson1
1St. George’s Hospital Medical School, London, UK; 2AstraZeneca, Alderley Park, Macclesfield, Cheshire, UK

Localised PRESS and MQF lactate edited 1H MRS were used to assess RIF-1 fibrosarcomas prior to and 24 hours after treatment with the vascular targeting drug ZD6126. Choline was significantly reduced 24 hours post-treatment (p<0.03) in treated tumours and increased in vehicle treated tumours. Tumour choline T2 showed a significant decrease (p<0.03) following treatment, whereas water T2 showed no change. There was no significant difference in the lactate/water ratio following the treatment.

**13:37 2034. 13C MRS and DNA Microarray Analysis Demonstrate Increased Phosphatidylcholine Breakdown Following Inhibition of the PI3K Signalling Pathway in HCT116 Colon Cancer Cells**

Nada M. S. Al-Saffar1, Laura E. Jackson1, Robert Te-Poele1, Paul Workman1, Sabrina M. Ronen1, Martin O. Leach1
1Institute of Cancer Research, Royal Marsden NHS Trust, Sutton, Surrey, UK; 2Institute of Cancer Research, Belmont, Surrey, UK

Phosphoinositide 3-kinases (PI3Ks) play an important role in cancer. Using MRS we have monitored response to the PI3K inhibitor LY294002. 31P MRS showed an accumulation of phosphodiester (PDEs) following treatment. PDEs/NTP ratio, a parameter independent of cell number, also increased. This ratio could serve as an in vivo MRS marker of PI3K inhibition. 13C MRS showed an accumulation of 13C labelled glycerolphosphocholine (GPC), suggesting that GPC may be coming from enhancement of phosphatidylcholine breakdown. Taken together, we have shown that MRS could be used to non-invasively monitor response to novel PI3K-targeted therapeutic drugs.

**13:38 2035. Increased Diffusion Coefficient Correlates with Decreased Choline in Response to Cyclophosphamide Therapy of RIF-1 Tumors**

H Poptani1, S Pickup1, E.J. Delikatny1, S Magnitsky1, A Mancuso1, D S. Nelson1, J D. Glickson1
1University of Pennsylvania, Philadelphia, Pennsylvania, USA

High choline and low apparent diffusion coefficients (ADCav) are suggestive of high cell density which correlates with tumor malignancy. We have measured ADCav, total choline/CH3 and CH2/CH3 ratios in RIF-1 tumors before and after cyclophosphamide (Cp) treatment to assess their role in monitoring early response to therapy. ADCav increased from 0.85±0.02 to 1.08±0.01 x10-9 m2/s (p <0.001) while TCho/CH3 and CH2/CH3 ratio decreased from 0.75±0.06 to 0.34±0.05 (p<0.05) and 2.09±0.23 to 1.32±0.19 (p<0.005), respectively, after 72h of Cp treatment. These changes reflect decreases in tumor proliferation and cell density leading to an increase in extra-cellular volume fraction.

**13:39 2036. Phospholipase Activity Accompanies Glycerophosphocholine Production in Phenylbutyrate-Treated Prostate Cancer Cells**

M Milkevitch1, G. Zheng1, S. Pickup1, E.J. Delikatny1
1University of Pennsylvania, Philadelphia, Pennsylvania, USA

Numerous MRS studies have shown that chemotherapy causes increased glycerophosphocholine (GPC) levels in cells and tumors, often suggested to arise through phospholipase A2 (PLA2) activation. In this study, DU145 prostate cells were treated with the differentiating agent phenylbutyrate to induce MR-visible increases in total choline and GPC. In situ phospholipase activation was measured using a self-quenching fluorescent phospholipid, PED-6. The significant time-dependent increase in total choline and GPC was accompanied by increased fluorescence from BODIPY released from PED-6. The combination of these modalities provides evidence that these MR-detectable metabolic changes can be attributed to phospholipase activation.

**13:40 2037. Serial Measurements of Tumour Tissue Oxygen Tension in the Shionogi Model of Prostate Cancer using 19F NMR**

Jennifer McNab1, Andrew Yang1, Piotr Kozlowski1
1The Prostate Centre at Vancouver General Hospital, Vancouver, British Columbia, Canada

19F NMR of Perfluoro-15-Crown-5-Ether (PFC) was used to make serial measurements of in vivo partial oxygen pressure (pO2) in Shionogi tumours. In vitro calibration curves defined a linear relation between R1 of PFC, pO2 and temperature at 2.35T. An emulsion of PFC was administered to tumour bearing mice intravenously or neat compound was injected intratumourally. Non-localized T1 measurements of intratumoural PFC were made at multiple time points throughout the tumour cycle. From the in vitro calibration curves, these T1 values were translated into pO2. A trend of increasing pO2 was observed up to around 7 days post androgen-ablation.
MR Spectroscopy of Brain: Animal Models

Room 510      Tuesday 13:30 - 15:30

13:30  2038. Proton Spectra in Aged Rats: Correlation with Learning Abilities
Daniel Jirak1, Katerina Namestkova2, Martin Burian1, Ivan Vorisek1, Eva Sykova2, Milan Hajek1
1Institute for Clinical and Experimental Medicine, Prague, Czech Republic; 2Institute of Experimental Medicine, ASCR, Prague, Czech Republic

The purpose of this study was to examine changes in the 1H spectra in aged rats and to correlate these data with their learning abilities. We show that the changes in Glu, Ins, Cr and NAA concentrations in aged rats, as compared to young rats, were higher for bad learners than for good learners. We observed a significantly lower concentration of Cr in rats with poor learning ability compared with good, thus we conclude that the Cr concentration may be a marker of learning disability.

13:31  2039. Quantitative Mapping of Lithium in Rat Brain at Therapeutic Doses by Spectroscopic Imaging
Subbaraya Ramaprasad1, Jiaxiong Pi1, Elzbieta Ripp1
1University of Nebraska Medical Center, Omaha, Nebraska, USA

Lithium (Li) is the drug of choice in the treatment and prophylaxis of bipolar illness. Both the therapeutic and neurotoxic side effects of Li are centered mainly in the central nervous system. However, the relationship of lithium in different brain regions to its function remains largely unknown. The mechanism by which neurotoxic side effects are generated is not known and maybe related to distribution of Li in the brain. The regional specificity in lithium's brain distribution could underlie important steps on its action. The utility of 7Li MR technique to map Li distribution in the brain is discussed.

13:32  2040. Localized 1H Spectroscopy in the Primary Visual Cortex V1
Christoph Juchem1, Hellmut Merkle2, Nikos K. Logothetis1, Josef Pfeuffer2
1Max Planck Institut für Biologische Kybernetik, Tübingen, Germany; 2National Institutes of Health, Bethesda, Maryland, USA

The primary visual cortex V1 is the elementary target, when visual function and cortical reorganization are investigated. The study demonstrates that online analysis of field distributions is helpful to assess local spectral quality. At 7T metabolite line widths of less than 10Hz could be reproducibly achieved, when regions of field disturbances were avoided. Profiting from 3D field analysis and a combination coil setup at high field, the feasibility of localized single voxel spectroscopy in the primary visual cortex (1.5-1.7mm diameter) was demonstrated in the macaque monkey.

13:33  2041. In Vivo 1H MRS Study of Transgenic Glucose Intolerant Rats
Kimmo K. Lehtimäki1, Teemu P. Laitinen1, Miika V. Heinonen1, Karl-Heinz Herzig1, Juhana M. Hakumäki1
1University of Kuopio, Kuopio, Finland

We have performed brain and skeletal muscle 1H NMR-spectroscopic measurements in transgenic (overexpression of acyl-CoA binding protein) glucose-intolerant rats in vivo at 4.7 T. Myo-inositol (mI) resonances were significantly elevated in comparison to control animals. Although elevated intra-myo-cellular lipid (IMCL) content is commonly associated with insulin resistance and diabetes, the muscle IMCL levels in the glucose-intolerant rats were no different from normal controls. Our results show that pathological glucose intolerance caused by overexpression of acyl-CoA binding protein has no effect on muscle lipids, however brain metabolism may be slightly affected.

13:34  2042. Chronic Endotoxin Exposure Decreases Choline and Increases Lactate as Measured by Ex Vivo 1H MRS
Christine C. Cloak1, Linda Chang1, Jenna Passman2, Sulie L. Chang2
1Brookhaven National Laboratory, Upton, New York, USA; 2Seton Hall University, South Orange, New Jersey, USA

We evaluated the effects of acute and chronic injections of the endotoxin lipopolysaccharide(LPS) on brain metabolites in four groups of rats that received either chronic saline or LPS, followed by acute saline or LPS. Ex vivo extracts of the hypothalamus were studied with 1H MRS. Decreased choline and increased lactate were observed. This study shows the feasibility of 1H MRS to further study the effects of infection and stress on brain chemistry.
Clinical Cancer MR Spectroscopy
Room 510 Wednesday 13:30 - 15:30

Qiuhong He1, Jintong Mao2, Jonathan P. Dyke3, H. Michael Gach1, Xiangling Mao4, Dikoma C. Shungu4
1University of Pittsburgh, Pittsburgh, Pennsylvania, USA; 2University of Florida, Gainesville, Florida, USA; 3Weill Cornell Medical College, New York, New York, USA; 4Mount Sinai School of Medicine, New York, New York, USA

The Selective Multiple-Quantum Coherence transfer methods for breast cancer MRSI mapping of lactate was implemented on a GE 3T clinical scanner. A transmit/receive breast coil in a modified birdcage configuration was used to give excellent B1-field homogeneity and signal-to-noise ratio. This coil configuration may be optimized in the future for investigations on a 7T MR scanner to search for tumor specific markers and to improve the diagnostic specificity of breast cancer.

13:31 2044. Clinical Breast MRS at 1.5T using a Water-Fat Suppression Technique
Ingrid S. Gribbestad1, Trond E. Singstad1, Anders Kristoffersen1, Kjell A. Kvistad1, Ivar T. Jonsson1, Steinar Lundgren1, Stefan Roell2
1St. Olavs University Hospital, Trondheim, Norway; 2Siemens AG, Erlangen, Germany

Most malignant breast tumours are characterised by high choline signal in MR spectra. A reduction of the lipid signal would help clinical interpretation of the spectra, due to better delineation of the choline signal. The aim with the present study was to implement and test out the feasibility of a water-fat suppression technique in a clinical breast MRI/MRS protocol. Fat-water signal reduction was obtained using the spectral saturation method, by which transverse magnetisation is dephased selectively before and after the second slice selective 180-degree spin echo pulse. The sequence can easily be included in a clinical MR/MRS protocol.

13:32 2045. A Study of Differentiation between Prostate Cancer and BPH in the Transitional Zone by 1H Magnetic Resonance Spectroscopic Imaging (MRSI)
Saying Li1, Min Chen1, Cheng Zhou1, Wenchao Wang1, Chen Zhang1
1Beijing Hospital, Beijing, People's Republic of China

To investigate the characterization of the spectra in prostate transitional zone using MRSI. Methods: Cho+Cr/Ci ratio and Cho/Cr ratio were evaluated in each voxel with cancer or BPH in the transitional zones of eighteen patients. Discriminant Analysis was used to determine the power of the two ratios in differentiation between cancer and BPH. Results: the two ratios in cancer voxels were significantly higher than those in BPH voxels (p<0.001). The specificity, sensitivity and accuracy are 98.6%, 85.7%, 92.9% respectively for the differentiation. Conclusions: prostate cancer is characterized by the higher CC/C ratio and C/C ratio in the transitional zone.

13:33 2046. Characterization of Prostate Cancer with HRMAS 1HMRS
Melissa A. Burns1, Chin-lee Wu2, Jennifer L. Taylor2, Leo L. Cheng2
1MGH, Charlestown, Massachusetts, USA; 2MGH/Harvard Med School, Boston, Massachusetts, USA

The diagnostic utility of prostate cancer tissue metabolites measured with ex vivo proton magnetic resonance spectroscopy (1HMRS) has been tested. Approximately 200 tissue samples from ~90 prostatectomy cases have been analyzed with high-resolution magic angle spinning (HRMAS) 1HMRS. Results of principal component analysis (PCA) of spectroscopy and quantitative histopathology performed on the same specimens indicate that 1) PCs thus identified can differentiate cancer from normal; 2) metabolites identified by the PCs can significantly differentiate cancerous versus non-cancer tissues from the same patient; 3) cancer metabolites can correlate with patient clinical status, such as, tumor perineural invasion, and pathological stages.

13:34 2047. Correlation of [Cit/(Cho+Cr)] ratio with ADC Values in Prostate Cancer Patients with PSA Level in the Range 4 to 20 ng/mL
Virendra Kumar1, Rajeev Kumar1, Sanjay Thulkar1, S C. Das1, N P. Gupta1, N R. Jagannathan1
1All India Institute of Medical Sciences, New Delhi, Delhi, India

We evaluated the correlation of [Cit/(Cho+Cr)] ratio with the ADC values between normal and malignant tissues of prostate cancer patients. Decreased [Cit/(Cho+Cr)] ratio and ADC values were observed for patients with PSA > 20 ng/mL. In patients with PSA level 4 – 20 ng/mL, the [Cit/(Cho+Cr)] ratio was decreased in many locations of peripheral zone and the corresponding ADC was 1.2 ± 0.09 x 10⁻³ mm²/s compared to 1.7 ± 0.25 x 10⁻³ mm²/s of normal tissues. Combined use of MRSI and DWI may be valuable for the diagnosis of patients whose PSA level is 4 to 20 ng/mL.
13:35  **2048. Diffusion Tensor Imaging and MR Spectroscopic Imaging of Prostate Cancer**

*Albert P. Chen*, *Duan Xu*, *Roland Henry*, *Aliya Qayyum*, *John Kurhanewicz*, *Daniel B. Vigneron*

1University of California, San Francisco, California, USA

Diffusion Tensor single-shot fast spin-echo (DTI-SSFSE) and 3D MRSI data were acquired from 26 patients with biopsy-confirmed prostate cancer. In regions of prostate cancer as well as regions of healthy prostate peripheral zone, a significant correlation was found between Dav (directionally averaged apparent diffusion coefficient) measured by DTI and MRSI metabolite ratios (p<0.0001). Lower Dav was associated with higher CC/C ratio. This study demonstrated that DTI and MRSI provided unique yet complementary information in the characterization of prostate cancer. While MRSI offers highly specific metabolic information, DTI offers 40-fold higher spatial resolution in delineating prostate cancers based on microstructural variations.

13:36  **2049. Differentiation between BPH and Prostatic Cancer using Diffusion-Weighted MR Imaging and 3D 1H-MR Spectroscopy**

*Min Chen*, *Sa Ying Li*, *Wen Chao Wang*, *Zhen Han Yang*, *Wei Feng Zhao*, *Cheng Zhou*

1Beijing Hospital, Beijing, People's Republic of China

To assess the usefulness of diffusion-weighted MR imaging and 3D 1H-MRS in differentiating between benign and malignant prostatic tissues., diffusion-weighted MR imaging and 3D 1H-MRS was performed in 23 consecutive patients with prostatic cancers. The ADC values were found to be lower in the malignant PZ than in the non-cancerous PZ and in the benign prostatic hyperplasia central gland. On 3D 1H-MRS, increased creatine-choline peaks and decreased citrate peaks with resultant increases in the Cho+Cr/Cit were observed in the malignant PZ. Therefore, the benign and malignant prostatic tissues can be differentiated based on diffusion-weighted MR imaging and 3D 1H-MRS.

13:37  **2050. Relationship between Lactate, Choline, Creatine and Perfusion Parameters in Newly-Diagnosed High-Grade Gliomas**

*Xiaojuan Li*, *Daniel B. Vigneron*, *Janine Lupo*, *Ying Lu*, *Susan Chang*, *Soonmee Cha*, *Sarah J. Nelson*

1University of California at San Francisco, San Francisco, California, USA

Lactate is the end product of the anaerobic glycolysis and abnormally increased lactate in brain tumors may be an indicator of hypoxia in these lesions. The goal of this study was to explore the relationship between lactate, choline, creatine and perfusion parameters using in vivo magnetic resonance spectroscopic imaging and perfusion weighted imaging techniques. Fourteen patients with newly diagnosed high-grade gliomas were studied. The volume of elevated lactate was found to be positively related with Cho-to-NAA abnormal volumes and maximum normalized peak height of the relative concentration curve of the perfusion data, and negatively related with Cr-to-NAA abnormal volumes.

13:38  **2051. Serial Assessment of Therapy Response for Low-Grade Glioma Patients through MR Diffusion, Perfusion, Spectroscopic, and Anatomical Imaging**

*Joseph A. Osorio*, *Susan Chang*, *Tracy R. McKnight*, *Sarah J. Nelson*

1University of California, San Francisco, California, USA

Nine chemotherapy patients with supratentorial Grade II gliomas were evaluated serially using MR diffusion, perfusion, and spectroscopic imaging. The relative levels of CNI, the apparent diffusion coefficient (ADC), and the relative cerebral blood volume (rCBV) parameters were analyzed within the regions of T2 hyperintensity and CNI contours. Seven of nine patients investigated that responded with a decrease in T2 presented a median decrease of 23.6%, one patient remained stable, and one patient showed progression. Results have shown that anatomical, metabolic, diffusion, and perfusion information together may provide a better assessment of patient progress and overall evaluation of therapy response.

13:39  **2052. Longitudinal Analysis in Patients with Glioblastoma Multiforme Treated with External-beam Radiation Therapy: Changes of Choline to N-acetylaspartate Index**

*Joonmi Oh*, *Roland G. Henry*, *Andrea Pirzkall*, *Ying Lu*, *Susan Chang*, *William P. Dillon*, *Sarah J. Nelson*

1University of California, San Francisco, San Francisco, California, USA

This paper shows the longitudinal changes of choline to N-acetylaspartate index (CNI) volume for patients with newly diagnosed glioblastoma multiforme (GBM) treated with external-beam radiation therapy (XRT) and chemotherapy after surgery, and tests predictive value of survival. It was observed that the CNI volume was reduced relative to that of pre-XRT in 17/28 patients who exhibited rather large CNI volumes pre-XRT (median value of -1.75 cc/month). Despite such reduction of the CNI volume after XRT, a significantly shorter median survival was observed for those patients indicating the prognostic importance of initial tumor burden.

13:40  **2053. Improved Preoperative Diagnostics of Brain Tumors by Quantification of 1H-MRSI Metabolites**

*Andreas Stadlbauer*, *Oliver Ganslandt*, *Stephan Graber*, *Christopher Nimsky*, *Rolf Buslei*, *Rudolf Fahlbusch*, *Ewald Moser*

1University of Erlangen-Nuremberg, Erlangen, Germany; 2Medical University of Vienna, Vienna, Austria

High-resolution 1H-MRSI was used to investigate changes of Choline (Cho), Creatine (Cr) and N-acetyl-aspartate (NAA) in 16 patients with gliomas. Molar concentrations for tumor in brain were calculated using LCModel. Metabolic maps were computed and integrated in a stereotactic-system to achieve correlation with histopathological findings of tumor-biopsy-samples. A linear correlation between the levels of [Cho] and [NAA] and the scale of tumor-infiltration were found. We found for all glioma grade II a [Cho]/[NAA]-value for tumor-center of less than 0.8 whereas for glioma grade III of greater than 0.8. These results can be helpful for preoperative diagnostics and therapeutic planning.
13:41  **2054. Proton-Decoupled 31P Magnetic Resonance Spectroscopy of Intra-Cranial Tumors**

Yu Leung Chan¹, David Yeung², Wai WS Poon¹, Ho-Keung Ng¹, Danny Chan¹, Yuen Yee Wong⁴, Francis Lee⁵

¹Chinese University of Hong Kong, Shatin, Hong Kong; ²Prince of Wales Hospital, Shatin, Hong Kong

Proton-decoupled 31P magnetic resonance spectroscopic imaging was performed in eight low grade gliomas, 18 high grade gliomas and 12 meningiomas. A low phosphocreatine level in meningiomas, low phosphodiesters in gliomas and meningiomas and high phosphomonesters and alkaline pH in high grade gliomas were observed. In the latter both phosphocholine and phosphoethanolamine were elevated relative to their glycerol derivatives with phosphocholine elevation shown to reach significant level.

13:42  **2055. Identification of Abscess Causing Microorganisms by in Vivo MRS**

Uwe Himmelreich¹, Greg Brown², James Taylor², Lavier Gomes³, James Ly⁴, Judy Soper⁴, Carolyn E. Mountford¹, Tania C. Sorrell³

¹University of Sydney, Sydney, New South Wales, Australia; ²Royal Adelaide Hospital, Adelaide, SA, Australia; ³Westmead Hospital, Sydney, New South Wales, Australia; ⁴Royal Prince Alfred Hospital, Sydney, New South Wales, Australia

Classification of infection causing microorganisms is essential for rapid initiation of optimal therapy. Current diagnosis depends largely on isolation of the pathogens. MRS was able to distinguish between abscess and tumours and to characterize abscess causing microorganisms. We were able to distinguish between anaerobe, aerobe, fungal, and sterile pus based on single voxel in vivo MR spectra of the abscess. Certain organic acids (butyrate, propionate) indicate the presence of particular taxa (Fusobacterium spp., Propionibacterium spp.).

13:43  **2056. Clinical Efficacy of Short-Echo Time Chemical Shift Imaging Compared to Single Voxel Spectroscopy**

Alexander Peter Lin¹, Asanka Widjesenke², Dominique Yang³, Frederick Shic³, Cathleen Enriquez¹, Brian David Ross¹

¹Huntington Medical Research Institutes, Pasadena, California, USA

Clinical efficacy of 1H MRS in brain tumor management has been established. We hypothesized that a combination of SV and CSI would be more efficacious than either alone. To facilitate comparison we developed short TE PRESS CSI and summed appropriate spectra to match SV acquired from a corresponding volume. CSI was less reproducible (variation 15–20%) than SV (variation 5–10%) and less sensitive (80%) to tumor differentiation. SV also resulted in errors (sensitivity 90%) due to incorrect voxel placement. A combination of SV and CSI at short TE proved most efficacious (sensitivity in biopsy proven studies=100%).

13:44  **2057. In Vivo Proton MR Spectroscopy of Salivary Gland Tumors**

Ann D. King¹, David Yeung², Anil T. Ahuja¹, Gary MK Tse², Edmund HY Yuen², Jeffrey KT Wong²

¹Chinese University of Hong Kong, Shatin, Hong Kong; ²Prince of Wales Hospital, Shatin, Hong Kong

The purpose of this study was to use localized proton MR spectroscopy to document the spectral characteristics of salivary gland tumors and to examine whether the choline/creatine (Cho/Cr) and choline/water (Cho/water) ratios can be use to characterize these tumors. Results obtained at TE 136 msec showed that both Cho/Cr and Cho/water ratios for Warthin’s tumor were significantly higher than pleomorphic adenoma and parotid cancers. The elevated Cho in Warthin's tumor may reflect the highly cellular nature of this lesion that results from a large number of lymphocytes.

**Clinical Cancer MR Imaging**

Room 510  Tuesday 13:30 - 15:30

13:30  **2058. 3D VIBE Imaging of Dura Mater in Patients with Meningioma**

Yasutaka Fushimi¹, Yukio Miki¹, Mitsunori Kanagaki¹, Takahiro Takahashi¹, Akira Yamamoto¹, Tsutomu Okada¹, Tabassum Naz Haque¹, Jun A. Takahashi¹, Nobuo Hashimoto¹

¹Kyoto University Graduate School of Medicine, Kyoto, Kyoto Prefecture, Japan

The appearances of dura mater of the brain on VIBE images have not been reported. In this study, the normal dura mater of 25 consecutive patients with meningioma was prospectively evaluated by 3D VIBE. Precontrast 3D VIBE images can visualize most of the normal dura mater frequently. Postcontrast 3D VIBE constantly showed enhancement of the normal dura mater. The anterior and middle fossa dura were thinner than that of the convexity. Postcontrast VIBE may be useful in evaluating the relationship between meningioma and its adjacent dura mater.
In 28 patients, diagnosed with gliomas, a simultaneous GE/SE EPI sequence was used to obtain GE (“total”) and SE (“microvascular”) relative cerebral blood flow (rCBF) and mean transit time (MTT). Both parameters were extremely heterogeneous both within a tumor and across subjects but the average rCBF was increased relative to contralateral brain. A significant correlation between GE and SE rCBF and grade was observed. No correlation between GE and SE MTT and tumor grade was found. The heterogeneity of the GE and SE perfusion parameters suggest that this approach will provide relevant information regarding the angiogenesis-induced hemodynamic abnormalities.

The purpose of this study was to investigate the use of image registration and subtraction techniques, applied to standard clinical imaging protocols, in the detection of marginal changes in tumour volume. 13 patients were selected on the basis of minimal or no change in tumour size reported after serial imaging. Serial T2 and FLAIR images were registered to appropriate baseline scans, subtracted, and assessed by three independent raters using a non-parametric rating scale. The mean tumour ratings were significantly higher after registration, but subtraction of the registered images did not offer any further improvement in tumour rating.

Multiple physiologic MR methods were considered for biopsy-confirmed GBM patients in order to more completely characterize glioblastoma multiforme (GBM). BOLD imaging was used to create maps of hypoxic regions. Chemical shift imaging (CSI) obtained biochemical information, while perfusion and diffusion-weighted images provided data on vascularity and cellularity, respectively. Analysis and comparison of these physiologic parameters with conventional MR anatomical techniques yielded information regarding a tumor’s heterogeneous environment as well as extent. After more complete clinical trials, these physiologic parameters may have future use in diagnosing and predicting recurrences, as well as planning treatment more effectively.

We investigated the importance of MRI in follow-up of differentiated thyroid carcinoma (DTC). After the initial treatment which included "near" total thyroidectomy and radioactive iodine (131I) therapy, all patients required a long-term follow up. MRI was done in 14 DTC patients with non conclusive findings. Pre- and postcontrast T1-weighted, and T2-weighted spin echo images were obtained at 1.5 T machine. Cervical and/or mediastinal metastases were detected in 5 patients and excluded in 9 patients. MRI has its role in long-term follow up of DTC patients, especially in cases of regional metastases when the routine, standard diagnostic procedures are questionable.

A combination of dynamic magnetic resonance (MR) imaging and multiparametric ISODATA vector breast model has been used for the differential diagnosis of enhancing lesions of 28 patients. In 10/16 malignant and 4/11 benign cases with equivocal (type 2) enhancement patterns. The ISODATA vector model gave additional diagnostic information that is useful for final diagnoses.

Many studies have provided compelling evidence that the measurement of apparent diffusion coefficients (ADC) has potential for characterization of lesions in prostate. This method has not been validated, we make a preliminary attempt here. After imaging eight excised human prostates and visually coregistering the ADC values with whole-mount pathology, we find that there are distinct variations in ADC values among tissue types, and also that the heterogeneity seen in human prostates may necessitate additional studies to conclusively differentiate cancer from benign structures.
13:37 2065. Analysis of Intrathoracic Tumor Mobility During the Whole Breathing Cycle by Dynamic MRI and Application for an Individualized Safety-Margin Concept in Radiotherapy Planning

Christian Plathow1, Sebastian Ley1, Christian Fink1, Michael Puderbach1, Waldemar Hosch1, Jürgen Debus2, Hans-Ulrich Kauczor2
1German Cancer Research Center, Heidelberg, Baden-Württemberg, Germany; 2University of Heidelberg, Heidelberg, Baden-Württemberg, Germany

Dynamic MRI is a simple non-invasive method to evaluate intrathoracic tumor mobility for radiotherapy planning. Because of the high variability of tumor mobility an individualized safety-margin concept is recommended.

13:38 2066. Quantitative and Semiquantitative Evaluation of Erythropoietin Conditioned Signal Intensity-Alterations in MRI of Femur in Patients with Cancer Anaemia

Nadir Alexander Ghanem1, Daniel Schmitz1, Carsten Altehoefer1, Henner Sturzenecker1, Martin Büchert1, Mathias Langer1
1University Hospital Freiburg, Freiburg, Germany

In our assessment we want to demonstrate quantitative and semiquantitative signal intensity (SI)-alterations of the femoral bone marrow conditioned by application of Erythropoietin in patients with cancer anaemia. Significant alterations for the metaphysis of Femur were seen in a T1 weighted SE sequence.

13:39 2067. Apparent Diffusion Coefficients in Cervix Cancer

Masoom A. Haider1, Zhaohe Zhang1, Igor Sitartchouk1, Michael Milosevic2, Anthony Fyles2, Timothy PL Roberts1
1University Health Network - Mount Sinai Hospital, University of Toronto, Toronto, Ontario, Canada; 2Princess Margaret Hospital-University Health Network, University of Toronto, Toronto, Ontario, Canada

The purpose of this study was to determine if there was a difference between the ADC of normal cervical stroma compared with cervix cancer. Thirteen patients with cervix carcinoma and 7 normal patients were imaged. ADC values were significantly lower in cervix cancer than normal cervix (p<0.001). The reason for this is unknown but may be related to higher cellular density and in cervix cancer. Although this data is preliminary it suggests that ADC has the potential to be used as a prognostic factor in cervix cancer.

13:40 2068. MRI of the Intraductal Papillary Mucinous Tumors of the Pancreas Correlated with Histopathologic Findings

Frank Pilleul1, Anne Rochette1, Jean-Yves Scoazec1, Christian Partensky1, Pierre-Jean Valette1
1Hôpital Edouard Herriot, Lyon, France

IPM tumors of the pancreas represent about 1% of pancreatic exocrine tumors. In the evaluation of common pancreatic diseases, MRI with MRCP is a noninvasive alternative to evaluate ductal anatomy without risk of complications. Because MRI of the pancreas is valuable in characterizing neoplasms, especially combined with MRCP sequences, it is interesting to establish the role of MRI in pre-operative statement of IPM pancreatic tumor.

13:41 2069. Comparison of Physiological and Descriptive Parameters of Intensity-Time-Curves Derived from Gd-DTPA Enhanced Dynamic MRI for the Assessment of Prostate Cancers in Patients.

Fabian Kiessling1, Matthias Philipp Lichy1, Rainer Grobholz2, Melanie Heilmann1, Nabeel Farhan1, Maurice Michel2, Lutz Trojan3, Jörg Ederle1, Stefan Deformes1, Hans-Ulrich Kauczor1, Wolfhard Semmler2
1German Cancer Research Centre, Heidelberg, Germany; 2University of Mannheim / Heidelberg, Heidelberg, Germany

To investigate detection of prostate cancers by mathematical and physiological parameters of DCE-MRI. Twenty-five patients were examined with Gd-DTPA enhanced MRI. ROI were defined in tumors and non-affected areas. Data were parameterized in amplitude and kep (two-compartment model). Slope, area under the curve (AUC) and tlag were determined. Slope showed superior sensitivity and specificity for discriminating tumors. Amplitude, kep and AUC were also significantly higher in tumors. tlag did not discriminate carcinomas from glandular tissue. Although pharmacokinetic models in DCE-MRI suggest a pathophysiological basis for tumor characterization, in this study discrimination of prostate cancers was more reliably using descriptive parameters.

13:42 2070. Relation between Dynamic Gadolinium Uptake Rate and Response to Chemotherapy in Colorectal Liver Metastases: Preliminary Results

Hanneke van Laarhoven1, Jelle Barentsz1, Mark Rijpkema1, Cornelis Punt1, Arend Heerschap1
1UMC Nijmegen, Nijmegen, Netherlands

Assessment of tumor vasculature by dynamic contrast enhanced MRI (DCE-MRI) may provide a useful non-invasive measure for the prediction of treatment outcome and the follow up of chemotherapy. In this study 19 patients underwent DCE-MRI before start of therapy. Response was evaluated after 2 months of chemotherapy, using the RECIST criteria. As yet no relation between pre-treatment values of Gadolinium-DTPA uptake rate kep and response to chemotherapy was observed in patients with liver metastases of colorectal cancer.
**Poster Sessions**

**Cancer MR in the Brain**

**Room 510**  
**Wednesday 13:30 - 15:30**

**13:30  2071. Arterial Spin Labeling Perfusion Imaging for Evaluation of Brain Tumors at 3 Tesla**  
Barbara A. Appignani¹, David B. Hackney¹, Guillaume Duhamel¹, Eric T. Wong¹, Julian Wu¹, Robert Marquis¹, David Alsop¹  
¹Beth Israel - Deaconess Medical Center, Boston, Massachusetts, USA

The feasibility of utilizing arterial spin labeling to measure perfusion in clinical cases of brain tumors was examined. A five minute examination of the entire brain produced excellent images for interpretation, without artifacts. ASL studies reveal different features of brain tumors when compared to gadolinium enhanced images. Further study is necessary to determine whether the perfusion data is a reliable parameter for making therapeutic decisions for the management of brain tumors.

**13:31  2072. Attention Deficits in Survivors of Childhood Cancer**  
Robert James Ogg¹, John Sexton¹, Ping Zou¹, Robert Butler², Raymond Mulhern¹  
¹St. Jude Children's Research Hospital, Memphis, Tennessee, USA; ²Oregon Health Sciences University, Portland, Oregon, USA

Children surviving cancer or cancer therapy that affects the central nervous system are at risk for neuropsychological and cognitive impairments impacting academic performance and quality of life. Evidence from behavioral studies suggests cancer and therapy-induced deficits in attention underlie these impairments. We report fMRI measurements in childhood cancer survivors that show altered patterns of brain neural activity during a continuous performance task, as compared to healthy siblings, and that altered brain activity is associated with differences in behavioral performance between the groups.

**13:32  2073. Differentiation of Metastatic and Non-Metastatic Rodent Prostate Cancer using a New Mathematical Model to Fit Dynamic Contrast Enhanced MRI Data**  
Xiabing Fan¹, Milica Medved¹, Jonathan N. River¹, Marta Zamora¹, Claire Corot³, Philippe Robert³, Philippe Bourrin², Martin Lipton¹, Gregory S. Karczmar¹  
¹University of Chicago, Chicago, Illinois, USA; ²Guerbet Laboratories, Roissy, France

Multi-slice dynamic contrast enhanced magnetic resonance imaging (DCEMRI) data were analyzed using a newly developed empirical mathematical model to distinguish metastatic from non-metastatic rodent prostate cancers. This is a test of the use of MRI to identify malignant cancers in patients, and distinguish them from benign masses. Uptake and washout of a low molecular weight contrast agent (Gd-DTPA) and a higher molecular weight contrast agent (P760) were studied. The results demonstrate that the metastatic tumors have a significantly lower washout rate than the non-metastatic tumors, combined with higher maximum concentration.

**13:33  2074. The Accuracy and Limitation of Two-Component Model for Correcting T₁ Influence in Dynamic Susceptibility-Contrast MRI in the Presence of BBB Breakdown**  
Yi-Jui Liu¹, Wen-Chau Wu¹, Hsiao-Wen Chung¹, Cheng-Yu Chen¹, Chun-Jung Juan¹  
¹Yuan-Pei University of Science and Technology, Hsin-Chu, Taiwan; ²UCSD Center for Functional MRI, La Jolla, California, USA; ³National Taiwan University, Taipei, Taiwan; ⁴Tri-Service General Hospital, Taipei, Taiwan

Assuming intact blood-brain-barrier, first-pass dynamic susceptibility-contrast MRI can be used to semi-quantitatively measure cerebral blood volume. Once the contrast agent leaks into the interstitial space, it causes T1 shortening effect. To separate intravascular T2* signal and leakage effect, Weisskoff proposed a two-component model which was recently modified to achieve self-correction. However, the accuracy and limitation remain unclear. In this study, we use simulation to reinvestigate the feasibility of the two strategies. Results show that the correction using white matter signals recovers T2*-weighted signals from extravascular T1 effect better than other methods, with mean error about 10% in three leakage conditions.

**13:34  2075. The Mean Transit Time (MTT) Reflects the Amount of Blood Brain Barrier Breakdown Due to Microvascular Proliferation in Glioblastoma Demonstrated by Perfusion Weighted Imaging (PWI)**  
Stephan Ulmer¹, Cartsen Liess¹, Nadine Otto¹, Kay Engelland², Claus C. Gheuer², Olav Jansen³  
¹Institute of Radiology, Luebeck, Germany; ²Medical Physics, Kiel, Germany; ³Section of Neuroradiology, Kiel, Germany; ⁴Department of Radiology, Flensburg, Germany

One of the characteristic histopathological findings in glioblastoma is a pathological microvascular proliferation. Using a bolus-traced dynamic T2*-weighted EPI sequence, maps for rCBV, rCBF and MTT can be determined. In glioblastoma rCBV and rCBF were increased compared to the grey matter of the affected hemisphere, whereas grey matter of the affected or non-affected hemisphere did not differ. Furthermore MTT was doubled in the tumor tissue displaying mechanisms of leakage of contrast agent even though the brain tumor receives more volume at a higher flow. This reflects arterio-venous shunting in the glioblastoma with an additional steal effect of the tumor.
13:35   **2076. Differentiation of Tumor Recurrence from Radiation-Induced Necrosis Using Diffusion Tensor Imaging**  
*Qian Dong*, *Pia Sandgren*, *Patrick Weybright*, *Suresh K. Mukherji*, *Robert C. Welsh*, *Thomas L. Chenevert*  
1University of Michigan, Ann Arbor, Michigan, USA

In this study we investigate the ability of diffusion tensor imaging (DTI) in distinguishing new contrast enhancing lesions as tumor recurrence or non-neoplastic therapy related change. Sixteen patients (9 cases of tumor recurrence, 7 cases of radiation necrosis) were studied by using DTI technique. Quantitative ADC and FA values were calculated in the region of the contrast-enhancing lesions. ADC values for tumor recurrence were significantly higher than those for radiation-induced necrosis. A decreased FA was identified in both groups. Our initial results suggest that DTI can potentially provide a non-invasive means to distinguish between tumor recurrence and radiation necrosis.

13:36   **2077. Perfusion and Diffusion MRI as Tools for Monitoring Anaesthetic Regimes in Patients Subjected to Craniotomy for Brain Tumors**  
*Mads Rasmussen*, *Niels Juul*, *Peter Vestergaard-Poulsen*, *Georg E. Cold*, *Carsten Gyldensted*, *Leif Østergaard*  
1Århus University Hospital, Århus, Denmark

To facilitate brain tumor surgery, substances that reduce intracranial pressure are often used. Propofol and indomethacin effectively reduces cerebral perfusion pressure (CPP) and ICP. Their usage in brain tumor surgery is controversial, as they are believed to cause ischemic damage. We used PWI and DWI to monitor CPP (the inverse of MTT) and possible emergence of ischemic lesions before during and after administration of the drugs. No ischemic lesions emerged on DWI, and PWI delineated important CPP changes in response to drug administration during anaesthesia. We believe PWI and DWI may prove important tools in testing new anaesthetic regimes.

*Stephan Gruber*, *Andreas Stadlbauer*, *Vladimir Mlynarik*, *Oliver Ganslandt*, *Ewald Moser*  
1University of Vienna, Vienna, Austria; 2University of Erlangen-Nuremberg, Erlangen, Germany

An LCModel-based software strategy to reconstruct anatomically matched voxels (AMV) of high resolution spectroscopic imaging (SI) data is presented. Data are reconstructed with and without susceptibility correction to simulate lower resolutions. Both tumour data at 1.5 T and data from a healthy volunteer at 3 Tesla showed superior data quality compared to simulated lower-resolution data: SNR is improved and artefacts are strongly reduced. High resolution SI allows the construction of AMV with high specificity as only tissue from the specific anatomic or pathologic regions is included.

13:38   **2079. Glutamate/Glutamine Complex, Myoinositol and Lipid in Late Radiation-Induced Injury of the Brain: An In Vivo 1H MRS Study**  
*Yu Leung Chan*, *David Yeung*, *Sing Fai Leung*, *Francis Lee*  
1Chinese University of Hong Kong, Shatin, Hong Kong; 2Prince of Wales Hospital, Shatin, Hong Kong

Forty-six patients with radiation-induced temporal lobe injury were examined on 1H MRS using a TE of 30 ms. A significantly higher Glx/Cr was shown in temporal lobes with lesion (p=0.002), mass effect (p=0.008) compared to those without. A significantly lower mI/Cr was shown in temporal lobes with mass effect (p=0.016) compared to those without. Glx/Cr increased with increasing morphological severity. There was a decreasing trend of mI/Cr with more severe mass effect except for the most severe grade. Lipid was found in ten temporal lobes. The metabolite changes seem to reflect an underlying ischemic process accompanied by osmolarity changes.

13:39   **2080. 1H-MRS Resonance at 2.05 ppm in Mucin Producing Adenocarcinoma Metastases in the Brain**  
*Isabella Maria Björkman-Burtscher*, *Elisabet Englund*, *Gunnar Skagerberg*  
1Department of Diagnostic Radiology, Lund, Sweden; 2Department of Pathology, Lund, Sweden; 3Department of Neurosurgery, Lund, Sweden

To retrospectively evaluate whether a resonance at 2.05 ppm in the in vivo 1H-MR spectrum (TR 1500 ms, TE 272 ms) from brain metastases correlates with the histopathological tumour type in 20 consecutive patients. The resonance at 2.05 ppm was identified in three cystic adenocarcinoma metastases with production of mucin, and could not be identified in non-mucinous adenocarcinoma metastases or metastases of other histological type.

13:40   **2081. Neuroglial Tumor Proton Spectroscopy**  
*Paul Y-K Wang*, *Peter Varallyay*, *William Coshow*, *Greg Wilson*  
1OHSU, Portland, Oregon, USA; 2National Institute of Neurosurgery, Budapest, Hungary; 3Philips Medical Systems, Seattle, Washington, USA

Abstract: Neuroglial tumors contain both neuronal and glial elements and are the slowest growing CNS tumors, we report our experience in MR proton single voxel and CSI spectroscopy in 6 neuroglial tumors: gangliocytoma(1), gangliogliomas(4) and DIG(1), all classified as favorable low grade WHO grade I tumors. These tumors all have good prognoses but are rare entities, with the commonest, gangliogioma, representing 1% of brain tumors. There was great variation in Cho/NAA ratios (0.6-3.9) and average Cho/NAA ratios was 1.8 in gangliogliomas, higher than reported for low-grade gliomas.
**13:41 2082. Quantitation of Human Hepatic Tumors In Vivo by Phantom Replacement Method of Proton MR Spectroscopy at 3 Tesla**

Chunwei Li, Ywue-Chun Kuo, Chauo-Ywuen Chen, Yin-U Cheuo, Fon-A She, Twet-Shium Jaw, Gin-Chung Liu

1Kaohsiung Medical University, Kaohsiung, Taiwan, Taiwan

Quantification of choline-containing compounds in hepatic tumors using 1H MRS technique is of great interest since such compounds have been linked to malignancy. In this study, we demonstrate a practical external phantom replacement method for absolute quantification of hepatic metabolites at 3 T using a body coil. In phantom studies, results showed good accuracy compared with the known concentrations. In normal brain studies, after corrections for coil loading and T1 and T2 effects, results showed good consistency with those published before. This technique was further applied to two patients with hepatocellular carcinoma (HCC) to demonstrate the feasibility of this technique.

**Steady State Free Precession Imaging**

Room 553  Monday 14:00 - 16:00

**14:00 2083. IR TrueFISP: Analytical Expressions for Calculation of T1, T2 and Spin Density and Investigation of Off Resonance Influences**

Peter Schmitt, Mark A. Griswold, Vikas Gulani, Markus Kotas, Michael Flentje, Axel Haase

1Universität Würzburg, Würzburg, Germany

In this work, a complete set of analytical solutions is provided for the direct calculation of T1, T2 and spin density from the signal time course sampled with a series of TrueFISP images after spin inversion which may be described with a three parameter monoeponential function. The influence of off resonance frequency effects is analyzed with numerical simulations and the feasibility of the technique for fast acquisition of parameter maps is demonstrated in an in-vivo study on the human brain. In healthy volunteers, T1, T2 and spin density maps were obtained, and are in good agreement with literature values.

**14:01 2084. A "Variable Flip Angle" Radial Steady State Free Precession Technique**

Zhiqiang Li, Scott W. Squire, Arthur F. Gmitro, Eric W. Clarkson, Maria I. Altbach

1University of Arizona, Tucson, Arizona, USA

A radial steady-state free precession method (RAD-SSFP) has been developed to obtain high-resolution images with “variable flip angle” contrast from a single k-space data set. From the signal intensity changes with flip angle, a parameter R is derived, by fitting the experimental data to the steady state free precession equation. Since R is a factor that depends solely on the relaxation parameter T1 and T2, it can potentially be used for tissue characterization. RAD-SSFP may offer a fast and quantitative method that can be used in the clinic to characterize pathologies.

**14:02 2085. TOSSI (T-One insensitive Steady State Imaging): Sequence Optimization and First Results in Tumor Patients**

Peter Schmitt, Markus Kotas, Michael Flentje, Axel Haase, Peter M. Jakob, Mark A. Griswold

1Universität Würzburg, Würzburg, Germany

With the TOSSI concept, fast acquisition of purely T2-weighted TrueFISP images is achieved by inserting non-equally spaced inversion pulses. Thus, if the magnetization alternatively resides in states parallel and antiparallel to B0 for adequate periods TP and TA, T1 contrast is efficiently removed from the resultant TrueFISP images. Here, an analytical expression is derived for the ideal signal time course. From this, optimized temporal schemes can be calculated. Brain tumor patients were examined with a single-shot TOSSI sequence. The TOSSI images obtained within 2s essentially contained the same contrast as images acquired with a T2-weighted TSE sequence.

**14:03 2086. Fast Frequency Mapping with Balanced SSFP: Theory and Application to Proton-Resonance Frequency Shift Thermometry**

Klaus Scheffler

1University of Basel, Switzerland

A method is presented for rapid acquisition of frequency maps based on multi echo balanced steady state free precession (SSFP). This technique was applied to measure temperature changes within a gel phantom based on the temperature sensitive water proton-resonance frequency.

**14:04 2087. SNR Enhancement in Radial SSFP Sequences using Partial k-space Averaging**

Stefanie Winkelmann, Tobias Schäffter, Holger Eggers, Olaf Dössel

1University of Karlsruhe, Karlsruhe, Germany; 2Philips Research Laboratory, Hamburg, Germany

In real-time MR imaging spatial and temporal resolution are mainly SNR limited. The present work suggests a method to further enhance SNR by improving k-space signal sampling. 2D measurements are performed using a radial SSFP sequence with additional sampling on the refocusing gradients for partial and total k-space averaging. Tests on phantoms substantiate the relationship between k-space averaging and SNR improvement. In vivo tests allowed averaging of 35% of k-space corresponding to a SNR improvement in the order of 20% without prolonging the scan time.
14:05  **2088. Improved MRI Detection of Low Concentration Paramagnetic Contrast Agent using Steady State Fully Coherent Gradient Echo Sequences**

Edwin Heijman¹, Jacques den Boer¹, Rolf Lamerichs², Gustav J. Strijkers¹, Klaas Nicolay¹

¹Eindhoven University of Technology, Eindhoven, Netherlands; ²Philips Medical Systems, Best, Netherlands

In this *in vitro* study we show that Balanced-FFE and Rephased-FFE (steady state fully coherent gradient echo sequences, echo as well as FID rephased) offer a marked gain in sensitivity of up to a factor 6, in the detection of low concentrations of contrast agent, when compared to the commonly used T₁-FFE sequence. The increased sensitivity is demonstrated both theoretically and experimentally using a concentration series of Gd-DTPA in MnCl₂ doped water. These sequences are therefore attractive candidates for the *in vivo* detection of disease markers using targeted contrast agents.

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**Rapid Imaging Methods**

Room 553  Wednesday 13:30 - 15:30

13:30  **2089. Echo Planar MRI Cardiac Frequency Maps in a Single Shot Using Simultaneous Echo Refocusing (SER)**

Timothy Gordon Reese¹, Van J. Wedeen¹

¹Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts, USA

Current methods of cardiac shimming suffer serious limitations. Frequency maps, used for shimming, must be calculated by comparing multiple acquisitions with different phase evolution times. The background phase of these acquisitions must be stable in the presence of change in position, change in velocity, and time-dependent field variations. In the present abstract, we describe a simultaneous echo refocusing (SER) method for calculating frequency maps. SER collects all the needed data for a 2D frequency map in a single EPI shot, effectively freezing motion. Here we demonstrate the stability and reproducibility of this new method for cardiac shim data collection.

13:31  **2090. Fast B¹ Mapping with EPI**

Enrico De Vita¹, David Lee Thomas¹, Ralf Deichmann¹, Robert Turner¹, Roger John Ordidge¹

¹University College London, London, UK

Inhomogeneity of the rf excitation/reception field (B₁) in conventional MR methods leads to image contrast and signal-to-noise non-uniformity; it can also complicate quantitation of parameters (such as proton density, relaxation times and metabolite concentration) and prevent accurate grey/white matter segmentation. The problem is exacerbated at high magnetic fields. A method combining a hard pulse preparation, EPI acquisition and Fourier transform based data processing is here presented, allowing the B₁ distribution to be reliably and quickly obtained in-vivo. The method, successfully applied at 4.7T, may be extremely useful for quantitative MR and help in developing methods less sensitive to B₁ inhomogeneity.

13:32  **2091. Interactive Contrast Switching during Real-Time MRI**

Tobias Schaeffter¹, Steffen Weiss¹

¹Philips Research, Hamburg, Germany

We have developed a real-time MR-technique that allows interactive switching between two contrast mechanisms during continuous imaging. The technique uses a steady state free precession technique with high contrast and signal to noise ratio for the visualization of the anatomy and a spoiled gradient echo technique for the superior visualization of a contrast agent during injection. The interactive contrast switching was tested for cartesian and radial readout trajectories during real-time scanning.

13:33  **2092. Accelerated MR Imaging via FOLDing the Non-Fourier Encoded Dimensions.**

Dimitris Mitsouras¹, Bruno Madore², Frank J. Rybicki², Larry P. Panych², Alan Edelman¹, Gary P. Zientara²

¹Massachusetts Institute of Technology, Cambridge, Massachusetts, USA; ²Brigham And Women's Hospital, Boston, Massachusetts, USA

A general framework combining the UNFOLD imaging method with non-Fourier spatial encoding is described. UNFOLD compacts the k-space information necessary at each time frame by packing it along the time dimension. When the compacted k-space at each time frame is encoded via digital non-Fourier spatial excitations, both fewer RF excitations are necessary to completely encode each time frame, and the length of each digital RF excitation is reduced. Using this framework we show that the speedup in acquisition time obtained via UNFOLD and that obtained via non-Fourier encoding are compounded. We demonstrate the method on a commercial MR scanner.
13:34 2093. **Shifting Echoes Without Tremendous Signal Loss: T2*-Weighted, Double Echo-Shifted Gradient Echo Imaging**

Markus Klarhöfer, Klaus Scheffler

1University of Basel, Basel, Switzerland

The signal intensity of echo-shifted sequences rapidly decreases with increasing number of TR-shifts between excitation and echo collection. Although increasing T2* sensitivity, modification of the single-echo shifted sequence into a double-shifted version is thus hampered by the small signal intensity of the corresponding F2 state. However, using RF-spoiling the distribution of magnetization along increasingly dephased states is nearly flat (spread spectrum) and exhibits higher signal intensity than non-spoiled types. As a result, the rf-spoiled, doubled-shifted echo amplitude is only about 10% smaller than the single-shifted, and can be used for rapid T2*-weighted fMRI or perfusion studies.

13:35 2094. **3D High Resolution Skin Imaging**

Jin Hyung Lee, Neal K. Bangerter, Chuck Cunningham, Julie C. Dicarlo, Bob S. Hu, Dwight G. Nishimura

1Stanford University, Stanford, California, USA; 2Palo Alto Medical Foundation, Palo Alto, California, USA

Patients with diabetes have disease in the skin that is currently diagnosed using biopsy. Therefore, skin imaging using non-invasive modality such as MRI can be useful. The challenge in imaging skin using MRI is that ultra-high resolution needs to be achieved in relatively short scan time. To achieve sufficient SNR for the high resolution, a customized small surface coil was used while fast imaging was achieved using stack-of-spiral trajectories with spectral-spatial excitation to selectively excite water component.

13:36 2095. **Fat Suppression and Imaging in EPI Time Course Using Modulation with Thresholded Correlation**

Andrzej Jesmanowicz

1Medical College of Wisconsin, Milwaukee, Wisconsin, USA

A new method of fat suppression is introduced that takes advantage of a time-course of EPI acquisitions. The magnetization component Mz at a fat resonance frequency is modulated sinusoidally by a series of RF pulses, one pulse per TR, with a period of 8 acquisitions, for example. A fat image is created by correlating a time series with a known modulation frequency. This image is subtracted from all images with variable weighting computed automatically on an image-by-image basis.

13:37 2096. **T2ρ-Measurement with a Hyperecho-T2ρ-Sequence: Principles and First Results on Humans at 3T**

Juergen Hennig, Maxim Zaitsev

1Sect.of Medical Physics, Freiburg, Germany; 2University Hospital Freiburg, Freiburg, Germany

A method to measure T2-relaxation in the rotating frame (T2rho) by use of a hyperecho-T2rho sequence is presented. First results on human volunteers acquired at 3T show an increase in signal intensity with B1 at low B1-fields (< 100 Hz). This can be explained by suppression of T2'-effects. T2rho-measurements may thus allow to characterize the distribution of internal fields in tissue and therefore afford a new contrast parameter to look at tissue microstructure.

13:38 2097. **A New Pulse Sequence for Rapid Spin-Locked MR Imaging**

Ari Borthakur, Justin Halvershorn, Eugene Gualtieri, Mark Elliot, Andrew J. Wheaton, Ravinder Reddy

1University of Pennsylvania, Philadelphia, Pennsylvania, USA

Recently, spin-lock (or T1-rho) MRI techniques have the capability to measure blood flow and rates of oxygen metabolism in vivo. These dynamic MRI studies require rapid imaging techniques that can also perform quantitative MRI. To this end, a 2D T1?-weighted MRI pulse sequence based on an echo-planar readout was developed and implemented on a 1.5T clinical MR scanner. Images of the brain from a healthy volunteer demonstrate the utility of this technique for rapid mapping of T1-rho relaxation times.

13:39 2098. **Water-Fat Separation for Fast Spin Echo Imaging in an Inhomogeneous Field with Progressive Encoding**

Hector E. Avram, David Kramer, Ilya Simovsky

1Toshiba America MRI, South San Francisco, California, USA

We have implemented progressive encoding by shifting all echoes in a FSE sequence by various time differentials to gather water-fat encoding information. An algorithm was designed to calculate water and fat images based on the following: the least-square solution space for the field inhomogeneity is essentially a two-point space. Based on the fact that the field error changes slowly between neighboring pixels, of all possible subspace of solutions, the most smooth is chosen. It is further smoothed by a polynomial fit. This choice was used for the image separation which carries an error depending on the phase increment.
In single-shot STEAM MRI each stimulated echo requires a slice-selective read-out RF excitation and a gradient rephasing the stimulated echo. Thus, the efficiency of the sequence, i.e. the time used for data acquisition with respect to the measurement time, is not optimal. To improve the efficiency and to allow access to very short acquisition times, a few gradient echoes were acquired in addition to the stimulated echo in each read-out interval. Thereby, two different k-space sampling schemes can be applied that minimise susceptibility-related artifacts or maximize the SNR.

Rosette trajectories can be considered as the single shot variant of PR imaging. Due to destructive interference in the over-sampled center of k-space off-resonance signals are suppressed in the reconstructed images. The possibility to use continuously repeated rosette trajectories to acquire multiple images with increasing T2*-weighting was evaluated. With the cyclic symmetry of the trajectory, images of any echo time can be reconstructed retrospectively. In addition, the reconstruction can be performed at any given off-resonance frequency, thus allowing to recover signal in regions of field inhomogeneity. These unique properties allow maximizing the information content extracted from a single-shot acquisition.

We analyze the problem of finding the readout time, which maximizes the SNR when performing MRI of short T2 species. We demonstrate that for a fixed voxel size, the optimal readout time can be accurately estimated using an analytic approximation. The analytic form is found for both mono-exponential and biexponential decay. We have found that this approximation agrees well with experimental results and that it can be easily generalized for more complex relaxation behavior such as in multiple quantum filtered sodium MRI.

A number of techniques exist for acquiring single-shot, T2-weighted images using multiple RF refocusing pulses. RARE and HASTE suffer from the disadvantage that non-selective RF must be used due to the large number of refocusing pulses. GRASE requires fewer refocusing pulses, making slice-selection a practical option, but has a complex signal modulation in k-space. This paper describes an alternative approach, which also requires relatively few refocusing pulses, but avoids the type of signal modulation seen with GRASE. Computer simulations confirmed that the point-spread-function obtained compares favourably with that of GRASE. Initial images are shown from healthy volunteers.

Brain water content measurement has important clinical application in detecting brain disorders. Brain tissue water fraction can be converted from a T1 value based on their relationship already found. A full-brain T1 mapping pulse sequence based on a multi-slice inversion recovery fast spin echo pulse sequence is proposed here. This sequence is implemented with a slice-ordering technique that efficiently uses the scan time without any compromise of image quality. Phantom study on T1 quantification with this sequence shows a good agreement with basic multi-slice spin echo results.

Varying the flip angle during an FSE readout train can significantly reduce RF power while retaining SNR, but at a cost of image blurring. This study was performed to determine the SNR benefit of variable refocusing flip angle FSE when controlling for low-pass filtering effects. It was found that if the data from a variable refocusing flip acquisition were corrected to remove low-pass filtering, the SNR was decreased compared to an equal-power constant flip angle acquisition. Likewise, more SNR could be gained by applying an identical low-pass filter to the constant flip angle data than by variable flip angle refocusing.
13:46  **2105. 3D Ultra-Fast Spin Echo Inner Volume MRI: Neuroimaging Applications**


1Massachusetts Institute of Technology, Cambridge, Massachusetts, USA; 2Children's Hospital, Boston, Massachusetts, USA; 3Brigham And Women's Hospital, Boston, Massachusetts, USA

Ultra-Fast Spin Echo (UFSE) refers to the use of a train of ultra-short non-selective (hard) tightly packed refocusing RF pulses to produce the readout train. Inner volume UFSE imaging (IVUFSE) relies on using the first one or two RF pulses to perform highly selective spin selection of a desired volume, and subsequent imaging via a UFSE train. Two neurological applications of IVUFSE, imaging of the brain and spine, are presented. Results indicate that high resolution, high SNR imaging of the region of interest can be achieved in time comparable to current (lower resolution) methods.

13:47  **2106. 3D Turbo-Spin-Echo Imaging with up to 1000 Echoes per Excitation: From Faster Acquisitions to Echo-Volumar Imaging**

*John P. Mugler, III*, James R. Brookeman

1University of Virginia, Charlottesville, Virginia, USA

By taking advantage of the long echo trains that can be achieved with prescribed signal evolutions, we developed a single-slab 3D turbo-spin-echo sequence capable of acquiring multiple planes of k-space data following each excitation RF pulse. This technique is demonstrated by acquiring high-resolution 3D data sets of the whole brain (2 k-space planes, 330 echoes per excitation; isotropic 1-mm resolution in 4.9 min.) and internal auditory canals (3 k-space planes, 531 echoes per excitation), and by acquiring a complete 64 x 33 x 32 3D data set (1056 echoes) following a single excitation RF pulse (echo-volumar imaging).

13:48  **2107. Cramér-Rao Bounds for 3-Point Dixon Imaging**

*Angel R. Pineda*, Zhiwei Wen*, Scott B. Reeder*, Huanzhou Yu*, Norbert J. Pelc*

1Stanford University, Stanford, California, USA

We compute the Cramér-Rao Bound (CRB) for estimating the fat and water signals from a 3-Point Dixon acquisition. The CRB gives the lower bound on the variance of any unbiased estimator. We compare the predictions of the derivation with Monte Carlo simulations and in-vivo measurements. With an unknown field map, the estimation is nonlinear and this leads to unequal variances in the estimates fat and water and a singularity when fat and water are equal. We show that a nonlinear least squares algorithm with field map smoothing is optimal for regions where the field map is slowly varying.

13:49  **2108. VIPR Steady State Imaging with Diffusion Sensitivity**

*Bryan M. Donald*, Andrew L. Alexander*, Ethan K. Brosky*, Aiming Lu*, Walter F. Block*

1University of Wisconsin, Madison, Wisconsin, USA

We present a technique to create 3D isotropic imaging volumes with M- steady-state signal contrast using a 3D projection k-space trajectory. The sequence demonstrates sensitivity to water diffusion, as has been previously reported in 2D imaging. Complete coverage of the brain is possible in two minutes with little distortion in areas of high susceptibility.


*James William Goldfarb*

1Saint Francis Hospital, Roslyn, New York, USA

A strategy similar to catheter angiography where initial contrast injections (or even non- contrast time-of-flight scans) are done to locate vessel narrowings and further targeted studies are performed to confirm and more accurately depict suspect lesions will be presented. The TROTA technique is a further development of 2D complex subtraction Gd-enhanced MRA. Projection reconstruction techniques similar to those used in rotational catheter x-ray angiography are employed. Targeted angiography of four healthy volunteers was performed.

13:51  **2110. A Technique for High Spatial and High Temporal Resolution Dynamic MRI: Temporal KWIC**

*Hee Kwon Song*, Mitchell D. Schnall*, Lawrence Dougherty*

1University of Pennsylvania, Philadelphia, Pennsylvania, USA

A novel method is described for dynamic MRI that enables acquisition of a series of images with both high temporal and high spatial resolutions. Based on the projection reconstruction image acquisition scheme with a judicial choice of view angle ordering and temporally selective data filtering, the technique offers much greater image quality than other rapid projection reconstruction imaging schemes, affording enhanced SNR and reduced streaking artifacts. The feasibility of the technique is demonstrated in a 3D dynamic contrast-enhanced exam of the breast.

13:52  **2111. Assessment of Lower-Limb Perfusion using Rapid 3D Spiral Trajectories**

*Jin Hyung Lee*, Bob S. Hu*, Laurel Delapp*, Dwight G. Nishimura*

1Stanford University, Stanford, California, USA; 2Palo Alto Medical Foundation, Palo Alto, California, USA

Due to promising new interventional techniques such as gene or stem cell therapy, there is increased need for accurate measurement of perfusion deficits and post-therapy improvements. In this work, first-pass perfusion of the lower limb is assessed using variable-density stack-of-spirals trajectory to obtain full volumetric coverage with high temporal resolution. The temporal information over the whole lower limb was processed to quantify perfusion. The technique was verified through normal volunteers and nine patient studies.
2112. An Optimized 3D Interleaved Cylindrical Pulse Sequence with Reduced Oversampling

Kai Ruppert, John Mugler

1Advanced MRI Technologies, Sebastopol, California, USA; 2University of Virginia, Charlottesville, Virginia, USA

Previous implementations of 3D interleaved cylindrical gradient-echo pulse sequences used a constant number of interleaves for each of the concentric cylinders. The consequence was substantial oversampling in the central k-space regions. In this study we reduced the oversampling and achieved a 35% decrease in acquisition time while mostly preserving the image quality of the original non-optimized sequence. The main trade-off was a drop in signal-to-noise ratio and an increased level of background artifacts. Thus, a reduction in oversampling by decreasing the number of interleaves appears to be an effective way to reduce the acquisition time for cylindrical sequences.

2113. Excitation of Variable-Phase Profile for Efficient Saturation

Juan M. Santos, Charles H. Cunningham, John M. Pauly

1Stanford University, Stanford, California, USA

We present a method to design RF pulses with diverse phase and magnitude profile. This pulses can be used for simultaneous imaging and saturation at different spatial locations.

2114. Optimal Design of K-space Trajectories Using a Multi-Objective Genetic Algorithm

Brian M. Dale, Jonathan S. Levin, Jeffrey L. Duerr

1Case Western Reserve University, Cleveland, Ohio, USA

Non-rectilinear k-space trajectories are an area of active research due to their typically rapid acquisition times and benign artifact patterns. Trajectory design has commonly proceeded from description of a shape to investigation of its properties. It would be preferable to specify the desired properties, and derive a trajectory that best achieves those objectives. A multi-objective genetic algorithm is used to design trajectories with beneficial time, aliasing, flow, and off-resonance properties. The simulated objectives were found to correlate with reduced artifact levels in experimentally acquired images. The optimal trajectory is found to depend on a trade-off between speed and image quality.

2115. Gradient Waveform Design Using Genetic Programming

Daniel R. Thedens, Megha Navalgund

1University of Iowa, Iowa City, Iowa, USA

We investigated the design of gradient waveforms for arbitrary sampling trajectories using genetic programming (GP). GP mimics the process of evolution to generate solutions in the form of numerical functions or computer programs. We applied GP to the optimal design of gradient waveforms using acquisition time as the optimality criterion and gradient hardware limitations as constraints. The technique was demonstrated for variable density spiral acquisitions and found to be capable of generating closed form representations of efficient gradient waveforms for spiral imaging.

2116. Accelerating MRI by Skipped Phase Encoding and Edge Deghosting (SPEED)

Qing-San Xiang

1University of British Columbia, Vancouver, British Columbia, Canada

A novel method is proposed for scan time reduction. The k-space is under-sampled with skipped phase encoding steps, similar to the familiar methods of SMASH and SENSE. Aliasing artifacts are resolved using images from a single coil without sensitivity measurement. The method is based on the fact that high-pass filtering reduces probability of ghost overlapping for many practical images, allowing an effective deghosting of edge maps with a smaller number of overlapping ghost layers. Final image is obtained from deghosted edge map after an inverse filtering. Promising results have been obtained from in vivo studies.

Rapid Imaging Applications and Evaluation

Room 553 Monday 14:00 - 16:00

2117. Influence of Training Data Quality on k-t BLAST Reconstruction

Michael Schacht Hansen, Sebastian Kozerke, Jeffrey Tsao, Klaus Paul Pruessmann, Peter Boesiger, Erik Morre Pedersen

1University of Aarhus, Aarhus, Denmark; 2Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

The k-t BLAST technique allows for high acceleration factors in dynamic imaging by allowing some aliasing in r-f space which is resolved using low resolution data acquired in a training stage of the acquisition. The exact amount and quality of training data needed to keep reconstruction artifacts to a minimum is not well understood. In this study we use simulations and in-vivo data to establish general rules on a) the amount of training data needed, b) the degree of spatial registration of training and acquisition data, and 3) the need for filtering of the training data.
14:01 2118. Comparison of Analysis Methods for T1 Measurement by trueFISP Readout of Inversion Recovery
K E. Sakaie¹, W Shin¹, T J. Carroll¹
¹Northwestern University, Evanston, Illinois, USA

Accuracy of fast T1 measurement by trueFISP readout of inversion recovery was tested by comparison with standard measurements. Measurements were performed in a gelatin phantom and in brain of volunteers. Simple null-point determination of T1 was found to be more accurate than nonlinear least squares fits to exponential recovery, even after accounting for T2 weighting, pulse nonidealities, and frequency offsets.

14:02 2119. Fast and High Resolution Scans for Clinical and Neuro-Anatomical Volumetry Studies: Sub-Millimeter, Isotropic-3D MP-RAGE Sequence using SENSE in 5 Minutes at 3T
Yi-Ching L. Ho¹, Yih-Yian Sitoh¹, Peter C.M. van Zijl², Xavier Golay¹
¹National Neuroscience Institute, Singapore, Singapore; ²Johns Hopkins University, Baltimore, Maryland, USA

We demonstrate sub-millimeter, isotropic3D MP-RAGE scans using SENSE at 3.0T in 5min14s. This is advantageous for clinical research, as we get high spatial resolution scans suitable for quantitative morphometry, while keeping acquisition time within clinically relevant limits. For comparison of quality, we performed hippocampal volumetry in 5 epileptic patients and 5 controls, using both SENSE (5min, axial-reformatted-as-coronal) and non-SENSE (10min14s, native-coronal) MP-RAGE data. Within-subject discrepancies between the native-coronal or the reformatted-axial volumes were slightly larger in patients than controls, possibly due to greater movement in patients in between/during scans, again highlighting the need for faster acquisition times.

14:03 2120. Cardiac Cine 3d TrueFISP Parallel Imaging using Auto-Calibrating 2D-TSENSE
Peter Kellman¹, Andrew C. Larson¹, Qiang Zhang¹, Orlando P. Simonetti¹, Andrew E. Arai¹, Elliot R. McVeigh¹
¹National Institutes of Health, Bethesda, Maryland, USA; ²Siemens Medical Solutions, Chicago, Illinois, USA

Cardiac cine 3d imaging offers the potential for full heart coverage in a single, segmented breath-hold acquisition. A single acquisition eliminates breath-hold registration errors between slices in conventional 2d multi-slice imaging requiring multiple breath-holds. A trueFISP sequence combined with parallel imaging is used to achieve spatial resolution of 2.3 x 2.4 x 6 mm³ and approximately 50 ms temporal resolution within a single 20 heartbeat breath-hold. Parallel imaging uses 2d-TSENSE at acceleration rate 6 with a custom 8-element surface coil array.

14:04 2121. Aortic Arch to Intracranial 3D MRA with t-SLIT 3D-SSFP using a Neurovascular-Attached QD head SPEEDER Coil
Masao Yui¹, Mitsue Miyazaki¹, Hitoshi Kanazawa¹, Kazuya Okamoto¹
¹Toshiba Medical Systems Corporation, Ohtawara, Tochigi, Japan

Observation of aortic arch to intracranial MRA is clinically desired. An ASL technique, ECG-triggered 3D t-SLIT SSFP, is developed to selectively depict fast flow arteries. The technique allows a coronal plane acquisition to cover the aortic arch to intracranial arteries and permits remarkable scan time reduction using a neurovascular-attached QD SPEEDER coil.

14:05 2122. Design of a Cost-effective 6DOF Mechanical Armature for Real-Time MRI Scan Plane Prescription
Dingrong Yi¹, Graham Wright¹
¹Sunnybrook & Women’s College Health Science Center, University of Toronto, Toronto, Ontario, Canada

Existing user interfaces are either time consuming or non-intuitive to use for real-time MRI scan plane prescription. To address this problem, an efficient, intuitive and cost-effective 6 degree-of-freedom mechanical armature was designed and prototyped. In its input mode, a user can hold the normal of the scan plane and move it around to simultaneously prescribe its position and orientation in a coordinated manner. In its output mode, the plane can automatically move and follow user’s prescription to physically reflect the prescribed scan plane in a fixed reference coordinate system. Its workspace and accuracy is sufficient for real-time cardiac imaging.

Reconstructing Alternative k-Space Data and Alternative Encodings

Room 553  Tuesday 13:30 - 15:30

13:30 2123. An Improved TRICKS Method for Dynamic Contrast-Enhanced Tumor Imaging
Jim X. Ji¹, Michael Aref²
¹Texas A&M University, College Station, Texas, USA; ²University of Illinois at Urbana-Champaign, Urbana, Illinois, USA

TRICKS is a 3D dynamic imaging method where k-space data are temporally subsampled during data acquisition and then recovered by linear interpolation before image reconstruction. Significant error can be introduced when underlying signal variations show nonlinear behavior. This abstract presents a new image reconstruction scheme to improve the TRICKS method. Using a nonlinear interpolation scheme, the new method captures dynamic signal variations more accurately. Experimental results from a dynamic contrast-enhanced mice tumor study are presented to demonstrate the effectiveness of the proposed method.
Regridding Using Matrix Methods To Reduce Artefacts
Mark Bydder
UCSD, San Diego, California, USA

Image reconstruction using methods to reduce gross errors in the data have been studied.

Fast Gridding Methods for 3D Reconstruction
Philip J. Beatty, Dwight G. Nishimura, John M. Pauly
Stanford University, Stanford, California, USA

Reconstructing high-resolution 3D images from non-uniformly sampled k-space data can require gigabytes of memory and take hours to reconstruct even on modern computers. We show a gridding method which is particularly well suited to 3D reconstruction, producing acceptable error levels while reducing memory requirements about 4X with comparable improvements in speed.

A Comparison of Iterative and Non-Iterative Approaches For Sampling Density Compensation in PROPELLER Imaging.
Ashish Anil Tamhane, Mark Anthony Anastasio, Konstantinos Arfanakis
Illinois Institute of Technology, Chicago, Illinois, USA

In PROPELLER image reconstruction, the k-space data is multiplied with a weighting function to compensate for the non-uniform sampling density, before interpolation onto a Cartesian grid and Fourier transform to image space. A non-iterative and an iterative approach have been proposed to estimate this weighting function. In this study, the two methods were compared under different sampling conditions. When sufficiently sampling k-space with a PROPELLER grid the two approaches produced similar results. In contrast, iterative estimation of the weighting function produced superior results than the non-iterative method in case of k-space under-sampling.

Refinements in Reconstruction of Spiral-In Imaging Improve fMRI of the Frontal and Hippocampal Areas
Atsushi M. Takahashi, Yi-Fen Yen
Robarts Research Institute, London, Ontario, Canada; London Health Sciences Centre, London, Ontario, Canada

The Spiral-In pulse sequence effectively reduces signal dropout in regions of magnetically varying susceptibility. However, reconstruction of these images require attention to avoid artifacts resulting from the reversed spiral trajectory. The utility of the spiral-in technique with modifications to the reconstruction algorithm is demonstrated in fMRI of the Frontal and Hippocampal areas.

EXTended Rosette ACquisition Technique (EXTRACT) : A Dynamic R2* Mapping Method using Extended Rosette Trajectory
Sangwoo Lee, Douglas Noll, Jeffrey Fessler
University of Michigan, Ann Arbor, Michigan, USA

We propose a new dynamic estimation scheme of R2* map, field map, and image using extended rosette trajectory. In the method, the estimation is done by log-linear fitting of a series of sub-images. The sub-images were reconstructed from segmented k-space data, via minimizing the least square error with spatio-temporal smoothness penalties. A phantom and a functional study demonstrate that the proposed method can provide accurate estimates of R2* map, and detect functional activation in brain.

Analytical Investigation of Bias in Array Coil Combination
Mark Bydder
UCSD, San Diego, California, USA

Noise properties and a method for combining phased array coil data are presented.

SENSE Reconstruction using Feed Forward Regularization
Miha Fuderer, Johan van den Brink, Michel Jurrissen
Philips Medical Systems, Best, Netherlands

In MRI, the reconstruction of SENSE data can lead to local noise enhancement in some image regions. Regularization can help significantly, particularly if it is guided by a-priori knowledge. In our approach, the regularization-information is extracted from a low-resolution proton-density weighted reference scan, acquired with the quad body coil.

Non-Fourier Reconstruction Can Prevent Image Dropouts
Robert W. Cox, Leslie A. McCall
National Institute of Mental Health, Bethesda, Maryland, USA; Auburn University, Auburn, Alabama, USA

Unshimmable through-slice gradients cause image dropouts in EPI. Non-Fourier reconstruction can correct much of this problem, particularly if coupled with z-shimming during part of the readout window.
Two methods for image reconstruction for the PERL imaging sequence are presented. The PERL field encodes two dimensions simultaneously by employing a product of a PERiodic and a Linear spatial encoding field. Both reconstruction methods rely upon a Fourier reconstruction along the periodic dimension and a unique transform along the linear spatial direction of the PERL field. However the two methods differ in the order of operations with interesting consequences. In addition other aspects of the reconstruction are discussed, such as unwrapping echoes and phase correction for artifacts.

Reconstruction: Fat and Water

Room 553 Tuesday 13:30 - 15:30

13:30 2133. Improved Fat Suppressed SSFP Imaging using 3DPR
Paul Gurney1, Brian Hargreaves1, Dwight Nishimura1
1Stanford University, Stanford, California, USA

A method to correct for the partial-volume effects of phase-based fat suppression with SSFP is explored. Using the data provided by the prewinder and rewinder of a 3DPR trajectory in combination with the known relative phase behaviour of water and lipids across an SSFP TR, an estimate of the water component of an image is generated which does not suffer from partial volume effects.

13:31 2134. Phase Correction in Two-Point Dixon Water and Fat Imaging using a Three-Dimensional Region-Growing Algorithm
Jingfei Ma1
1University of Texas M. D. Anderson Cancer Center, Houston, Texas, USA

A 3D region growing algorithm was designed as an extension to a 2D region growing algorithm that was recently developed for phase correction in Dixon water and fat imaging. In comparison to 2D, the 3D algorithm allows for phase propagation into seemingly isolated regions via adjacent slices, and therefore the path followed by the 3D region growing is more reliable. We demonstrate improved water and fat separation with in vivo data from breath-hold abdominal imaging using dual echo in-phase and out-of-phase gradient echo sequence.

13:32 2135. Improving Image Contrast and Water/Fat Quantitation in Dixon Methods using a Multi-Spectral Fat Model
Jiping Zhan1, Jingfei Ma1
1University of Texas M. D. Anderson Cancer Center, Houston, Texas, USA

The single peak model for fat assumed in Dixon methods ignores its multi-spectral nature. In this research, we showed the amplitude and phase of the signals acquired in a Dixon acquisition deviate significantly from the theoretical predictions based on the single peak model. In comparison, a simple two-peak model provides much better description to the experiment. We further demonstrated that with the modified model, improved image contrast and more accurate water and fat quantitation can be achieved both in phantom and in vivo.

13:33 2136. An Automated Algorithm for Combining Multivoxel MRS Data Acquired with Multicoils
Nimrod Maril1, Robert E. Lenkinski1
1Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA

We present an automated algorithm which combines multivoxel MRS data acquired with multicoils into a weighted complex dataset. The algorithm uses the frequency domain fitting algorithm of LCModel to determine the phase corrections and the peak areas in each spectrum. Then the algorithm determines the dominant metabolite in each spatial location and weights the individual spectra. The combination of MRS data acquired from a phantom and the brains of normal volunteers yielded the theoretical predicted improved SNR. With this algorithm, multivoxel MRS data acquired with multicoils can be combined similarly to the routine combination of MRI data acquired with multicoils.

Reconstruction of Partial or Non-Rectilinear Data Sets

Room 553 Tuesday 13:30 - 15:30

13:30 2137. Alternate Interpolators for rBURNS without Deapodization
Peder Eric Zufall Larson1, John M. Pauly1
1Stanford University, Stanford, California, USA

We propose new windowed interpolators for use with Regularized Block Uniform ReSampling (rBURNS) that do not require deapodization correction. These are a Hamming-windowed jinc function and a Kaiser-windowed jinc function, which provide a flatter response in the field of view and reduce aliasing. They require approximately a 1.5X grid and obtain reconstructions comparable to deapodized sinc and jinc interpolators, as well as gridding.
13:31  **2138. Efficient Three-Dimensional Reconstruction for Non-Cartesian Acquisitions**  
*Daniel R. Thedens¹, Xuguang Jiang¹*  
¹University of Iowa, Iowa City, Iowa, USA

The purpose of this work was to investigate the feasibility and efficiency of performing complete three-dimensional (3D) image reconstruction with a modified BURS algorithm. The algorithm was applied to reconstruction of a 3D spiral-based trajectory with non-uniform sampling. The method pre-computed interpolation information for a given trajectory, reducing actual reconstruction time to two minutes for a 256 x 256 x 12 data set. The method was demonstrated on phantom data and shown to produce high-quality images.

13:32  **2139. Linear Interpolation in K-space**  
*Feng Huang¹, Ha Cheng¹, Andrew Rubin¹, James Akao¹, Randy Duensing¹*  
¹MRI Devices Corporation, Gainesville, Florida, USA

This technique, Linear Interpolation in K-space (LIKE) is an extension of the Generalized Auto-calibrating Partially Parallel Acquisitions (GRAPPA) reconstruction method. All acquired lines in K-space are used as auto-calibration signal (ACS) lines and the K-space is interpolated by utilizing neighbors from both different rows and different columns. Hence, more accurate results can be achieved. The method and its implementation are introduced and experiment results are compared with those of GRAPPA.

13:33  **2140. Proper Normalization for the Gridding Algorithm**  
*Yongxian Qian¹, Zhenghui Zhang¹, Pascal Spincemaille¹, Yi Wang¹*  
¹University of Pittsburgh, Pittsburgh, Pennsylvania, USA

The gridding algorithm is widely used in reconstructing non-Cartesian data and requires normalization during resampling. In this paper, we review the gridding algorithm and point out that for reconstructing partial k-space data, the proper normalization has to be based on the full k-space trajectory.

13:34  **2141. Fast Direct Reconstruction of Non-Cartesian k-space Data Using a Combined Discrete and Fast Fourier Transforms**  
*Yongxian Qian¹, Zhenghui Zhang¹, Yi Wang¹*  
¹University of Pittsburgh, Pittsburgh, Pennsylvania, USA

For reconstructing non-Cartesian k-space data, a fast direct reconstruction (FDR) method is presented by combining the discrete and fast Fourier transformation. Simulation and experimental data demonstrate that this FDR method may allow faster updating partial k-space than the standard gridding method.

13:35  **2142. Signal-to-Noise in TSE-Imaging with Incomplete k-Space Coverage: Strategies and Implications for Low-SAR Imaging at High Fields**  
*Juergen Hennig¹, Oliver Wieben¹, Matthias Weigel¹*  
¹University Hospital Freiburg, Freiburg, Germany

The SNR-behavior of TSE-sequences with incomplete sampling was examined for partial Fourier reconstruction as well as for parallel reconstruction using GRAPPA and mSENSE. Contrary to the expected loss of SNR with increasing reduction factor it is demonstrated, that SNR even increases, when less k-lines are sampled irrespective of the reconstruction technique. This is due to the uneven weighting of k-lines due to T2-relaxation along the echotrain as well as to the ‘focusing’ of signal around the k-space centre for samples of finite size.

13:36  **2143. Noise Analysis in the Multiple Receiver MR Experiment**  
*Amir M. Abduljalil¹*  
¹Ohio State University, Columbus, Ohio, USA

The approach in combining Complex data from different receivers is investigated. Two cases were considered; the sum of squares and the sum of the phased data. The statistical distribution functions were calculated. Significant signal-to-noise-ratio (SNR) improvement was observed for the phased sum case especially at low SNR values. In addition, the phased sum case provided better estimate of SNR than the sum of squares case.

13:37  **2144. Reconstruction Methods of 8 Channel Head Multi-Coil by Imitating Birdcage Coil Current Distribution**  
*Akira Nabetani¹*  
¹GE Yokogawa Medical Systems, Tokyo, Japan

The homogeneous images were reconstructed with 8 channel head multi-coil by imitating the current distribution of 8 element birdcage coil. The availability was checked in both simulations and actual MRI data. The 8 channel head multi-coil has 8 independent data from 8 coils so theoretically 8 different reconstructed images are available. This technique is one of them. The reconstruction methods of imitating another coil’s current distribution doesn’t need additional data (scan) to correct B1 distribution so this technique is considered useful to improve homogeneity or to change apparent B1 penetration according to the purpose of diagnosis.
At high-frequency MRI, dielectric effects lead to intrinsically non-uniform transmit/receive fields. The wavelength within the human body is comparable to its size. RF losses in the body also play an important role. These effects, in effect, lead to image non-uniformity. This can be corrected by filtering of the reference scan, which is a low-contrast scan made to obtain coil sensitivities for CLEAR or SENSE.

**Motion Artifacts and Correction**

*Room 553  Wednesday 13:30 - 15:30*

13:30  **2146. Phase Ordering with Automatic Window Selection (PAWS) with Half Fourier for Increased Scan Efficiency and Image Quality**

Permi Jhooti¹, Peter Gatehouse¹, Jenny Keegan¹, Alto Stemmer², David Firmin³

¹Royal Brompton Hospital, London, UK; ²Siemens, Erlangen, Germany; ³Imperial College, London, UK

Phase ordering with Automatic Window Selection (PAWS) (Jhooti et al, MRM 2000), has previously been presented as a technique which is resistant to changes in breathing whilst allowing the use of phase ordering to provide effective motion artefact reduction in an optimal time. The technique has been further developed to exploit the advantages of partial Fourier imaging to allow further improvements in scan efficiency and image quality. The two bin PAWS technique is robust against changes in breathing and allows images to be acquired in the optimal scan time in every acquisition.

13:31  **2147. Evaluation of Respiratory Triggering Algorithms**

Wesley M. Skeffington¹, Reed F. Busse¹, Jane W. Johnson¹, Robert H. Herfkens², Jean H. Brittain¹

¹GE Medical Systems, Menlo Park, California, USA; ²Stanford University, Stanford, California, USA

Respiratory triggering is a method to use physiologic monitoring to synchronize data acquisition to the respiratory cycle. Because breathing is not perfectly periodic, the algorithm used to process respiratory waveforms and generate triggers can have a significant impact on image quality. This study examined two algorithms, one based on waiting for a set period after a detecting an inspiration peak, and the other using a finite state machine. Metrics for data consistency were derived and, based on this analysis, the state machine algorithm performed significantly better for a variety of patient and volunteer breathing patterns.

13:32  **2148. Suppression of Respiratory Motion Artifacts in Free-Breathing Cardiac Cine MR Imaging**

Yo Taniguchi¹, Hisaaki Ochi¹, Tetsuhiko Takahashi¹, Shin'ichiro Umemura²

¹Hitachi, Ltd., Kokubunji, Tokyo, Japan; ²Hitachi Medical Corporation, Kashiwa, Chiba, Japan

A new method for monitoring respiratory motion—which enables cardiac cine imaging in free breathing—has been developed. This method uses information of an imaging slice to trace the respiratory motion. As a result, spins in the imaging slice are kept in a steady state and scan time is not prolonged. In the procedure of the monitoring, the linear correlation coefficient between the projections of the imaging slice is calculated. The method was used for retrospective respiratory gating in free-breathing cardiac cine imaging and obtained good images without respiratory-induced artifacts.

13:33  **2149. Motion Compensation Using Parallel Imaging Without Extra Reference Measurements And With Modified Reordering**

Stephan Kannengiesser¹, Mathias Nittka¹, Berthold Kiefer¹

¹Siemens Medical Solutions, Erlangen, Germany

MR imaging, especially with segmented imaging sequences, is very sensitive to motion, e.g., from swallowing in neck imaging, or in abdominal breathhold imaging by residual motion of the abdominal wall. Averaging is a common means to reduce artifacts caused by motion. Here, an averaging method is introduced using parallel imaging on subdivided data sets of a fully sampled experiment and subsequent recombination of images. Coil sensitivities are estimated from the original data set, making extra reference measurements obsolete. An optimized reordering scheme to minimize motion effects in the subdivided data sets is introduced, which improves artifact suppression.

13:34  **2150. Use of Multi-Channel Coil Sensitivities for Improved Detection of Motion with Orbital Navigator Echoes**

Heidi A. Ward¹, Clifford R. Jack Jr.²

¹GE Medical Systems, Rochester, Minnesota, USA; ²Mayo Clinic, Rochester, Minnesota, USA

Improved echo planar image quality obtained with parallel imaging techniques has increased the use of multi-channel head coils for applications such as FMRI. Here, we examine how multi-channel coils can improve prospective motion correction for FMRI when using orbital navigator (ONAV) echoes. ONAV signals before and after in vivo motions were analyzed on a channel-by-channel basis. Results show that anterior channels individually detect motion as well as quadrature head coils, while posterior channels can be sensitive to non-rigid motion between the head and neck. The multi-channel coil sensitivities thus allow motion detection to be tailored to the anatomy of interest.
13:35 2151. Motion Compensation Technique using Variable Density Spiral Trajectories
General Leung¹, Donald B. Plewes¹
¹Sunnybrook Hospital, Toronto, Ontario, Canada

A novel method of motion compensation using variable density spirals is described. The technique has been shown to work in phantoms as well as healthy volunteers. Furthermore, the spiral trajectory design parameters affecting artefact correction are explored.

13:36 2152. The Similarity-Based Navigator Echo (SIMNAV)
Marshall S. Sussman¹, Naeem Merchant¹, Graham A. Wright¹, Larry M. White¹
¹University of Toronto, Toronto, Ontario, Canada

In the presence of non-rigid-body motion, conventional navigator techniques will reduce, but not eliminate motion artifacts. The similarity-based navigator (SIMNAV) technique selects data based on maximal navigator similarity, rather than minimal navigator displacement as in conventional methods. This allows one to select specifically data that differs only by rigid-body displacements. Within such data, the effects of any residual motion can be eliminated completely with linear k-space phase factors. The SIMNAV technique is implemented in conjunction with a FIESTA sequence. The utility of this technique is demonstrated by application to non-ECG-gated, free-breathing cardiac imaging and imaging of joint kinematics.

13:37 2153. Variable-Density Oblique Spherical Navigator Echoes to Improve Performance in Measuring 3D Motion
Andreu F. Costa¹, Daniel Petrie¹, Maria Drangova¹
¹Robarts Research Institute, London, Ontario, Canada

Spherical navigator (SNAV) echoes have the potential to correct for rigid-body motion in 3D, however, several design considerations in the acquisition of helical-spiral SNAVs can greatly affect the overall performance of this technique. The slew rate limitation prevents acquisition of the poles of the spherical shell, and higher accuracy is attained in SNAV registration when the rotations are predominantly “along-thread.” In this study we tested modified SNAV trajectories that overcome the slew rate limitation and acquire points on the entire shell. The modified trajectories improved upon the SNAV technique’s accuracy in detecting 3-dimensional compound rotations by up to one-degree rms.

13:38 2154. 3D Rotation Matching Using Spherical Harmonic Transformation of k-Space Navigator
Yi-Fen Yen¹
¹London Health Science Center, London, Canada

I report the preliminary result of the 3D rotation matching using FFT-accelerated cross-correlation in simulated k-space data, as an evaluation of its potential for future applications in MRI.

13:39 2155. Using the Axis of Rotation of Polar Navigator Echoes to Rapidly Correct 3D Subject Motion
Andreu F. Costa¹, Yi-Fen Yen², Daniel Petrie¹, Maria Drangova¹
¹Robarts Research Institute, London, Ontario, Canada; ²Lawson Health Research Institute, London, Ontario, Canada

The axis of rotation (AOR) between two spherical navigator echoes (SNAV) can be used to initialize the minimization algorithm that registers SNAV data, and speed up the overall analysis. We have extended the AOR concept to an improved SNAV acquisition and analysis strategy that eliminates the need for a minimization algorithm entirely. To determine 3D rotations, the AOR between two polar SNAVs is found, and orbital navigator echoes acquired in planes normal to the AOR are registered. The technique detected compound rotations to ~0.5° accuracy in 100 milliseconds, indicating that 3D prospective motion correction is feasible with this technique.

13:40 2156. Non-Linear Motion Correction for Diffusion Imaging Using a Self-Navigated Cartesian-Based Sequence
Rita Gouveia Nunes¹, Peter Jezzard¹, Stuart Clare¹
¹University of Oxford, Oxford, Oxfordshire, UK

Multi-shot techniques can be used to obtain high-resolution diffusion-weighted images. However, the images become very sensitive to patient motion, resulting in severe artefacts. In order to obtain reliable information about the orientation of white-matter fibres, it is essential to compensate for these motion-induced phase errors, in general requiring non-linear corrections. The refocusing reconstruction method has been shown to correct for non-linear errors but to date has only been applied to spiral trajectories. We show here that this method is also effective when using EPI-based self-navigated sequences with the significant advantage of not requiring any re-gridding to the Cartesian grid.

13:41 2157. Interactive MRCP with Adaptive Averaging
Lucy Kershaw¹, Richard Black¹, Martin Graves², David Lomas²
¹Addenbrookes NHS Trust, Cambridge, Cambridgeshire, UK; ²University of Cambridge, Cambridge, Cambridgeshire, UK

An interactive version of a driven-equilibrium single shot fast spin echo sequence has been developed for MRCP imaging. The interactive system allows rapid localisation with a short TR then switching to thick slab projection for MRCP. Imaging in the same location allows the frames to be averaged to improve SNR but respiratory motion can impair the image quality in the average. Adaptive averaging can be used to correct for motion between frames, improving SNR and image quality to allow the detection of subtle duct strictures and irregularities during interactive scanning.
A General Formalism for Diffusion and Turbulent Flow Imaging

Frank Peeters
St-Luc University Hospital, Université Catholique de Louvain (UCL), Brussels, Belgium

A formalism is presented for imaging of coherent (flow) and incoherent (diffusion, turbulence) motion using general gradient waveforms. It describes the imaging process in the (position-velocity) phase space. A linear systems approach is used to analyze the effects of the gradient waveforms. The formalism is illustrated on the basis of two variants of the same basic pulse sequence: the Fourier Flow Method for turbulent flow and the Pulsed Gradient Spin Echo for diffusion. It allows one to clarify misconceptions such as diffusion time and explains for instance why widths of displacement profiles are underestimated in q-space imaging.

Flow-Insensitive, Motion-Compensated Balanced Steady-State Free Precession Imaging

Oliver Bieri, Jochen Leupold, Gerhard Laub, Klaus Scheffler
University of Basel, Basel, Switzerland; Section of Medical Physics, Freiburg, Germany; Siemens Medical Solutions, Los Angeles, California, USA

Although the completely balanced gradient scheme of steady state free precession pulse sequences (b-SSFP) cancel the leading zeroth order gradient moment terms of motional phase accumulation, changing phase and slice encoding gradients lead to changing residual first order gradient moments, and thus to non-constant phase increment over each TR intervall. A new b-SSFP method with nulled first order gradient moments and optimised adaptive gradient timing is presented which effectively avoids signal loss due to motion.

Correction of Motion Artefacts in High Resolution FSE Images

Maria Asuncion Fernandez-Seara, David T. Thomas, Robert Turner, Roger J. Ordidge
University College London, London, UK

The quality of MR images is often degraded by motion. The increase in SNR at high field strength allows acquisition of high resolution images, which are more susceptible to motion. The navigator echo technique is often used to detect motion. The navigator signal after Fourier Transformation yields information on the subject motion that is used to correct the k-space data. In this study, navigator echoes were added at the end of the echo train of a 2D FSE sequence. Significant improvements in image quality are shown after motion correction.

Single-shot Measurement and Correction of EPI Distortion Using an Oscillatory Magnetisation Pattern and Fourier-based Image Processing

Andrew Nicholas Priest, Enrico De Vita, Roger Ordidge
Universitätskrankenhaus Hamburg-Eppendorf, Hamburg, Germany; University College London, London, UK

Echo-planar imaging distortion poses severe problems at high field. Most distortion-correction methods acquire reference data in a separate acquisition. The distortion field may change significantly with motion, leading to inaccuracies when using previously acquired correction data, even after motion correction. We present a method which captures distortion information using a modulation pattern as in myocardial tagging, combining two images acquired in rapid succession to avoid stripes in the final image. The modulated images allow EPI distortion to be measured and corrected. The analysis uses a robust localised distortion measurement using Fourier analysis to determine the local oscillation period.

Correction of B1-Field Inhomogeneity of Surface Coils in the Analysis of DCE-MRI Experiments

Christian Ludwig, Dominick JO McIntyre, John R. Griffiths
St. George's Hospital Medical School, London, UK

For DCE-MRI studies of subcutaneous rodent tumours, the sensitivity gained by using a surface coil is attractive. However, the inhomogeneity of the B1-field generated by a surface coil leads to substantial errors in the calculated changes in T1. An accurate baseline T1-map may be obtained using an adiabatic inversion recovery (IR)-imaging sequence, but this is too slow for a dynamic study. A procedure for the determination of a spatial flip-angle map of a surface coil is presented. The correct flip-angle for each voxel can then be used within the analysis of the DCE-MRI images.
A Preliminary Investigation into the Use of Joint Entropy for Correction of Fold Over Artefacts

David J. Larkman¹, Jo V. Hajnal⁴
¹Hammersmith Hospital, Imperial College London, London, UK

Aliasing artefacts are common with even the most experienced MR operators. This work presents a preliminary investigation of the use of joint entropy between a reference image and an aliased image which allows aliasing to be removed. Tests on simulated data with a field of view reduced by a factor of two produced successful unfolding and preserved all image structure, contrast and lesions. The extent to which the approach can be generally applicable is under further investigation.

Rapid In Vivo Shimming with Current Constraints

Dong-Hyun Kim⁴, Gary Glover⁴, Daniel Spielman⁴
¹Stanford University, Stanford, California, USA

As higher field strength magnets become more available, the importance of shimming increases linearly. Localized in vivo shimming using higher order coils can reach its maximum power available in regions of poor homogeneity due to increased susceptibility effects. In this abstract, we present a rapid higher order shimming method which takes into account the current limitations of the power supply. In vivo data from the C-spine region is presented. The whole shim process can be effectively executed within one minute.

Non-Linear Phase Correction with an Extended Statistical Algorithm

Zheng Chang⁴, Qingsan Xiang⁴
¹University of British Columbia, Vancouver, British Columbia, Canada

This paper presents a new MRI phase correction method. The statistical linear phase correction method proposed by Ahn and Cho is extended to handle 2nd order non-linear terms, often important for polynomial expansion of MRI phase. The polynomial coefficients are statistically determined from a series of n-pixel-shift rotational differential fields (RDF) that represents local vector rotations of a complex image relative to itself after being shifted by n pixels. The n-pixel-shift RDFs can greatly enhance the SNR resulting in a more accurate phase correction. The feasibility of the method has been demonstrated with 2D experimental IR MRI data.

Measurement and Automatic Correction of High-Order B₀ Inhomogeneity in the Rat Brain at 11.7 Tesla

Jun Shen⁴, Shizhe Steve Li⁴, Zhengguang Chen⁴, Jehoon Yang⁴, David Letizia⁴
¹NIMH, Bethesda, Maryland, USA

It has been of considerable interest to measure and correct high-order B₀ distortions in rodents in vivo at very high field strength over a large brain region to facilitate studies which are susceptible to T₂* effects. Here we modify the FLATNESS method to measure and correct up to the fourth-order B₀ inhomogeneity. The slice shimming routine was demonstrated using phase mapping, SE and asymmetric SE EPI and localized 1H spectroscopy of the rat brain at 11.7 Tesla. The measured in vivo high-order B₀ inhomogeneity in terms of spherical harmonics should also provide useful criteria for shim design.

Distortion Correction for Susceptibility-Induced Artifacts in Spin Echo MR Images: Simulation Study at 1.5T and 7T

Boubakeur Belaroussi², Youssef Zaim-Wadghiri², Hugues Benoit-Cattin¹, Christophe Odet¹, Daniel H. Turnbull²
¹CREATIS Laboratory - UMR CNRS 5515, Villeurbanne, France; ²Skirball Institute of Biomolecular Medicine, New York, New York, USA

In this work, we present a simple and efficient method to correct susceptibility-induced distortions in Spin Echo MR images when an arbitrary distribution of magnetic field errors is known. Using this field map, an accumulation map is built. This accumulation map reflects the errors in frequency encoding experienced by the nuclei during the imaging process. Once the accumulation map is built, it can be used for the distortion correction process. The proposed method has been tested at 1.5T and 7 T, for an air-filled sphere surrounded by tissue.

Improvements in Single Shot Z-Shim Using Parallel Imaging

Keith Arron Heberlein¹, Xiaoping Hu¹
¹Emory University, Atlanta, Georgia, USA

Single shot z-shim techniques using echo-planar imaging readout rely on either multi-echo or interleaved echo techniques. In both cases, the final composite image suffers from image distortion due to an increased readout window. This effective readout window for either technique can be reduced by application of parallel imaging for reduced k-space encoding. The utility of the method is observed using a multi-echo z-shim technique with parallel imaging.
13:37 2170. Effects of $B_0$ and $B_1$ Inhomogeneity in Ultra-High Field MRI

Trong-Kha Truong1, Donald W. Chakeres1, Petra Schmalbrock1
1The Ohio State University, Columbus, Ohio, USA

To characterize the severe static ($B_0$) and radiofrequency ($B_1$) magnetic field inhomogeneity in ultra-high field ($\geq 7$ T) MRI, gradient echo (GE) and spin echo (SE) images of the human brain were acquired on healthy volunteers and postmortem subjects. The $B_0$ and $B_1$ inhomogeneity were experimentally mapped and/or numerically simulated, and correlated with the image artifacts. Whereas $B_0$ inhomogeneity affects predominantly GE images near air/tissue interfaces, $B_1$ inhomogeneity (i.e., variations of the local flip angle and receive sensitivity) affects SE images more severely and shows non-intuitive patterns. This knowledge will ultimately help develop better $B_0$ and $B_1$ inhomogeneity correction methods.

13:38 2171. Blind Removal of Lipids in $^1$H MRSI Using Constrained Non-Negative Matrix Factorization

Shuyan Du1, Xiangling Mao2, Dikoma C. Shungu2, Paul Sajda1
1Columbia University, New York, New York, USA; 2Mount Sinai School of Medicine, New York, New York, USA

Incomplete suppression of intense resonances due to tissue water and lipids in whole brain $^1$H MRSI, can often adversely affect the ability of the technique to yield diagnostic information contained in lower concentration metabolites. This study describes a novel approach, based on non-negative matrix factorization (NMF), for automatic removal of residual lipids and water from human brain $^1$H MRSI data. The results show that this technique uncovers the spectral patterns and distributions of different types of tissue, such that those that are associated with residual water and lipids can be separated and then removed from brain tissue spectra.

13:39 2172. Correction of $B_0$ EPI Distortions in Diffusion Tensor Imaging and White Matter Tractography

JongHooun Lee1, Mariana Lazar1, JeeEun Lee1, James Holden1, Ei Terasawa-Grilley1, Andrew L. Alexander1
1University of Wisconsin-Madison, Madison, Wisconsin, USA

In this study, we investigated the use of field maps to correct the image distortion in DTI studies of the human and macaque brains. The field map correction greatly reduced the local image distortion in 42 human brain studies and 4 macaque monkey studies. After correction, the correspondence of the DTI data to undistorted neuroanatomical images, such as T1-weighted structural scans, was greatly improved. The correction also improved the results obtained for white matter tractography studies of the human brain. Image distortion correction is strongly encouraged for precise tractography, surgical planning, and population-based comparisons.

13:40 2173. Exact Correction of Distortions Due to Static Field Inhomogeneities in Spin Echo Echo Planar Imaging

Duane A. Yoder1, J. Michael Fitzpatrick2, Cynthia B. Paschal1, J. Christopher Gatenby2
1State University of West Georgia, Carrollton, Georgia, USA; 2Vanderbilt University, Nashville, Tennessee, USA

Spin-echo planar imaging, though less prone to field-dependent distortions than gradient-echo EPI, is quite distorted at fields of 3T and higher. These distortions hamper the use of SE-EPI for measuring capillary changes at high fields. To correct these distortions, we apply a forward/reverse method that combines information from two successive, distorted SE-EPI’s to create an image with correct mapping of signal intensity and location. In this way, a series of SE-EPI’s acquired with alternating phase encoding gradient polarity can be reconstructed into an undistorted image series without any loss of temporal resolution, change in TE, or phase map computation.


Maxim Zaitsev1, Jürgen Hennig1, Oliver Speck1
1University Hospital of Freiburg, Freiburg, Germany

Echo-planar imaging (EPI) is an ultra-fast imaging technique prone to geometric distortion. The promising correction technique is based on the point spread function (PSF) mapping. Further developments of the PSF mapping are presented, which enable reliable fully-automated distortion correction of EPI images at high field strengths. The method is fully compatible with parallel imaging enabled EPI. Parallel imaging techniques can also be applied to accelerate the PSF acquisitions. PSF datasets can be acquired with acceleration factors higher than the number of coil elements.

13:42 2175. A Novel Reference-Scan-Free Method for Correction of Nyquist Ghost Artifacts in Echoplanar Brain Images

Yan Zhang1, Felix W. Wehrli1
1University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA

A common artifact in echo-planar imaging is the Nyquist ghost, which is typically overcome with the aid of a reference scan preceding the actual image acquisition. Here, a non-linear phase correction obviating the need for a reference scan is proposed. The method is based on computing the second moments of the even and odd sub-domains of the phase-encoding k-space data to retrieve the phase disparities between even and odd echoes. The method’s underlying assumption is that the images are dominated by their low-frequency symmetric part.
13:43  **2176. An Evaluation of the Use of UFLARE for Rapid Acquisition of B0 Field Maps for Undistortion of EPI**  
Mara Cercignani1, Philip A. Boulby1, Gareth J. Barker2, Mark R. Symms1  
1Institute of Neurology, London, UK; 2Institute of Psychiatry, London, UK  
This work investigates the use of ultra-fast low-angle RARE (UFLARE) for B0 field mapping purposes. A field mapping UFLARE was obtained by varying the evolution time of a displaced version of UFLARE. Its performance was quantitatively assessed using a phantom filled with water and oil, thus using chemical shift to mimic the effects of susceptibility. Standard spin-echo and gradient-echo field mapping sequences were also acquired for comparison.

13:44  **2177. Quantitative Evaluation of Metal Artifact Reduction Techniques**  
Shannon Kolind1, Alex MacKay1, Peter Munk1, Qing-San Xiang1  
1University of British Columbia, Vancouver, British Columbia, Canada  
Image distortions caused by differences in magnetic susceptibility have long been a problem in clinical imaging, especially in the presence of metal prostheses. While various methods for metal susceptibility artifact reduction have been suggested, it is difficult to determine the most effective approach without a quantitative evaluation of these techniques. In this study, a novel method of quantifying the artifact present in MR images is introduced, and used to compare several methods of reducing susceptibility artifact. Of these techniques, the metal artifact reduction sequence (MARS) is shown to be the most effective for reducing metal artifact.

13:45  **2178. A 3-Dimensional Phantom and Method for Mapping and Correcting Geometric Distortion in Magnetic Resonance Imaging**  
Deming Wang1, Gary Cowin1, David M. Doddrell1  
1The University of Queensland, Brisbane, Queensland, Australia  
A 3D phantom for mapping geometric distortion in MRI is described. This phantom was designed based on the concept that a point in space can be defined using three orthogonal planes. It contained 10,830 control points spanning a volume of 257.04 259.02 261.0 mm³, thus offering a comprehensive mapping of geometric distortion in 3D. The mapping for geometric distortion for the entire imaging space only involves a single scan, and often takes less than 10 minutes. Correction of geometric distortion using a range of models will be discussed.

13:46  **2179. A New Method To Correct Distortions In Echo Planar Imaging**  
Huairen Zeng1, J. Christopher Gatenby1, Cynthia B. Paschal1, John C. Gore1  
1Vanderbilt University, Nashville, Tennessee, USA  
A method to correct distortion in Spin echo EPI using two or more reference images that are prephased along the phase-encoding direction.

13:47  **2180. Image Distortion Due to Metal Sphere in a Phantom: Comparison of 2D and 3D TSE, and 2D View Angle Tilting**  
Tim A.J. Hopper1, Hee Kwon Song2, James M. Pope1, Felix W. Wehrli2  
1Queensland University of Technology, Brisbane, Queensland, Australia; 2University of Pennsylvania, Philadelphia, Pennsylvania, USA  
Imaging of patients with metal prosthesis is limited by its susceptibility. Although techniques exist to help alleviate the distortions, the extremely high susceptibility of stainless steel limits their effectiveness. Using a stainless steel phantom MRI images were obtained using 2D and 3D TSE and 2D View Angle Tilting (VAT) techniques. It is shown that the large magnetic field perturbations induced by stainless steel materials cannot currently be remedied with any of the approaches discussed. However, implant materials with susceptibilities lower by one order of magnitude, such as titanium, should be MR compatible with the above methods.

13:48  **2181. Spectral Characterization of Subvoxel Magnetic Susceptibility Deviations**  
Jan-Henry Seppenwoolde1, Mathilda van Zijtveld1, Chris J.G. Bakker1  
1University Medical Center Utrecht, Utrecht, Netherlands  
In this study, a spectral description of sub-voxel magnetic susceptibility deviations is given for cubical voxels. Because spectral broadening is the base of all observed susceptibility artifacts, a spectral description is expected to give a less acquisition-dependent description and characterization of distorting sub-voxel objects. Theoretical investigation shows the possibility of discrimination and characterization of particles that differ in strength and/or volume fraction, especially at higher frequencies related to regions spatially close to the particles. Preliminary results of experiments with a spherical air cavity and an aluminum sphere suggest the feasibility of discrimination and characterization with a spectral description of artifacts.
13:49  2182. MR Scanner Geometry Changes: Phantom Measurements Compared to Intracranial Contents Calculations
James MacFall1, Martha Payne1, K. Ranga R. Krishnan1
1Duke University Medical Center, Durham, North Carolina, USA

MR scanner geometry scale factors measured from images of a phantom over a period of 4 years are compared to MR morphometry measures of the total intracranial contents (ICC) in subjects participating in a longitudinal study of major depression. Ratios of ICC measured on the same subjects at different times show correlation with scanner geometry changes and results indicate potential use of the ICC as a self-calibration measure for scanner geometry changes.

13:50  2183. Importance of Susceptibility Effects in the Determination of Fractional Regional Blood Volume (fRBV)
Tina Pavlin1, George P. Topulos2, Jim P. Butler3, Ross W. Mair4, Ronald L. Walsworth1, Sam Patz5
1Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA; 2Brigham and Women's Hospital, Boston, Massachusetts, USA; 3Harvard School of Public Health, Boston, Massachusetts, USA

We have studied the effect of susceptibility gradients resulting from the use of ferumoxide intravascular contrast agent (FeridexTM) on the measurement of fractional volume (fV) at low (0.2 T) and high (1.5 T) field strengths using a dialysis canister as the model of capillary bed surrounded by tissue. Our measurements demonstrate significant signal losses at 1.5 T, but not at 0.2 T, suggesting that our method for measuring fRBV could safely be used at lower (0.2 T) field strengths.

13:51  2184. New Method for Correction for Distortion Caused by Static-Field Inhomogeneity in Gradient-Echo EPI
Duane A. Yoder1, J Michael Fitzpatrick2, Cynthia B. Paschal2, J. Christopher Gatenby3, Yansong Zhao5
1State University of West Georgia, Carrollton, Georgia, USA; 2Vanderbilt University, Nashville, Tennessee, USA

Geometric and intensity distortion arising from static-field inhomogeneity can be severe in gradient-echo echo-planar imaging (GE-EPI), especially at field strengths of 3T and higher. Reference-image correction methods are applicable but require many additional scans. We propose a method that requires only two additional scans: two spin-echo echo-planar images (SE-EPI) identical to the GE-EPI except for the addition of a refocusing RF pulse and the reversal of the phase-encoding gradient in the second SE-EPI. We apply our method to images of the head and show reductions in distortion that approximate the accuracy of a conventional spin-warp image.

13:52  2185. Assessment of Manufacturers' Correction Methods for Geometric Distortion in MRI using a 3-Dimensional Phantom
Deming Wang1, Gary Cowin1, David M. Doddrell1, Wendy Strugnell1
1The University of Queensland, Brisbane, Queensland, Australia; 2The Prince Charles Hospital, Brisbane, Queensland, Australia

High performance MRI systems with short gradient coils are often associated with greater geometric distortion problems and the current methods for geometric distortion correction offered by MRI manufacturers are 2D methods. Care needs to be exercised when these methods are applied to correct geometric distortion in MR images especially those acquired on systems with short gradient coils. We will present a full assessment of some of the MRI manufacturers’ correction methods using a recently developed 3D phantom and some shortfalls of these 2D correction methods will be discussed.

13:53  2186. Use of Spherical Harmonic Deconvolution Methods to Compensate for Non-Linear Gradients Effects on MRI Images
Huawei Zhao1, Andrew Janke1, Gary J. Cowin1, Graham J. Galloway1, David Doddrell1
1The University of Queensland, Brisbane, Queensland, Australia

High-speed gradients in the current generation of MRI scanners often sacrifice linearity for consequent speed improvements. Such non-linearity results in distorted images. A presentation of the problem from first principles and a correction method based on a gradient field spherical harmonic expansion is proposed.

13:54  2187. k-space Correction of Eddy Current-Induced Distortions in DW EPI
Theo Smponias1, David Johnston1, John Mayhew1, Nikos Papadakis1
1University of Sheffield, Sheffield, South Yorkshire, UK

A method for correction of eddy-current (ec) induced distortions in diffusion-weighted echo planar imaging (DW-EPI) is described. It performs reference measurements of the ec field within the EPI acquisition window, and uses them during image reconstruction. The technique was demonstrated in a small-bore scanner with no digital preemphasis, and suppressed the ec induced image distortions significantly. The method can be easily implemented in clinical scanners, and contrary to similar correction techniques, it does not require reference scans specific to individual acquisitions of the DW protocol.
**Fast Correction of the Gradient Field Non-Uniformity for Large FOV Continuously Moving Table Techniques**

Mohammad Sabati\(^1\), Nirupama Nagarajappa\(^1\), M Louis Lauzon\(^1\), Richard Frayne\(^1\)

\(^1\)University of Calgary, Calgary, Alberta, Canada

Effective methods for correction of gradient magnetic field distortions using \textit{a priori} error fields and field mapping, have been previously presented for an “unwarping” transformation. Large FOV (LFOV) imaging using a continuously moving table method acquires data in the hybrid \((x-k_x, k_y-k_z)\)-space that prevents the direct application of these traditional correction approaches in fast MR imaging applications. In this study, we propose a real-time hybrid-space data-combining strategy that minimizes gradient geometric distortion. Results in phantoms and humans show the rapid producing of 3D LFOV images with high spatial accuracy. This method allows correction of data acquired with variable table motion.

**Calibration of Gradient Propagation Delays for Accurate Two-Dimensional RF Pulses.**

Nigel Paul Davies\(^1\), Peter Jezzard\(^1\)

\(^1\)University of Oxford, Oxford, Oxfordshire, UK

Hidden delays in the gradient system can lead to artifacts in multi-dimensional selective excitation pulses, as well as other MR methods, in which the synchronization of gradient and RF waveforms is critical. The concern of this study was to optimize 2D RF pulses used for selective arterial spin labeling (SASL). The sensitivity of the 2D RF pulses to uncorrected time shifts between the gradient and RF waveforms, was used to accurately calibrate the gradient propagation delays. Simulations were used to confirm the effect of delays on one or both gradient axes on the resulting spatial profile.

**Effects of Eddy Current Induced Distortion on In Vivo Measurement of the Diffusion Tensor with EPI**

Yuji Shen\(^1\), Serena Counsell\(^1\), David Larkman\(^1\), Mary Rutherford\(^1\), David Edwards\(^1\), Jo Hajnal\(^1\)

\(^1\)Imperial College, London, UK

Diffusion-weighted images acquired with EPI are highly sensitive to distortions induced by eddy currents from diffusion gradients. These distortions can cause errors in the calculated diffusion tensor and consequently in maps of diffusion anisotropy and the orientations of tissue fibre tracts. Both linear and non-linear distortions are produced by eddy currents and both can be corrected. We have investigated the benefits of this kind of correction on diffusion tensor measurements and demonstrate that error reduction results in both more coherent patterns of direction for the diffusion tensor and clearer fractional anisotropy maps.

**SNR Recovery for Parallel EPI using Simultaneous Acquisition of Gradient Echo and Asymmetric Spin Echo (SAGA)**

Keith Arron Heberlein\(^1\), Xiaoping Hu\(^1\)

\(^1\)Emory University, Atlanta, Georgia, USA

Application of parallel imaging to fast scan techniques such as EPI, aim at reducing the reducing the EPI readout window duration, not to accelerate the image acquisition time, but rather to reduce image distortion. Consequently, the image SNR is reduced due to the shorter readout window. This paper describes a multi-echo EPI technique, which preserves the SNR of the non-accelerated EPI image and reduces image distortion using parallel imaging. The technique is validated in a human experiment.

**The Effect of Optimal Design of Low-Pass Filter with Image Type in RF Field Inhomogeneity**

Ik Hwan Cho\(^1\), In Chan Song\(^2\), Jung Su Oh\(^1\), Taik Kun Kim\(^1\), Kee Hyun Chang\(^2\), Dong Seok Jeong\(^1\)

\(^1\)Inha University, Incheon, Republic of Korea; \(^2\)Seoul National University Hospital, Seoul, Republic of Korea; \(^3\)Seoul National University, Seoul, Republic of Korea; \(^4\)Korea University College of Medicine, Seoul, Republic of Korea

The common method to remove RF field inhomogeneity [1] is based on homomorphic filtering [2]. Homomorphic filtering-based method is not only simple but powerful. In this method, however, cutoff frequency of low-pass filter may affect the performance of overall correction. In this paper, we suggested that cutoff frequency of low-pass filter must be appropriately set with different type images in using homomorphic filtering-based RF correction method. We evaluated the significance of the appropriate selection of cutoff frequency in segmentation simulation of T2 and PD-weighted images with RF field inhomogeneity.

**Suppression of Streak Artifacts in a Radial Scanning**

Shinji Kurokawa\(^1\), Yo Taniguchi\(^1\), Hisaaki Ochi\(^1\), Masahiro Takizawa\(^1\), Tetsuhiko Takahashi\(^2\)

\(^1\)Hitachi, Ltd., Kokubunji, Tokyo, Japan; \(^2\)Hitachi Medical Corporation, Kashiwa, Chiba, Japan

A new method for suppressing streak artifacts in a dynamic radial sliding-window scanning was proposed. The method controls the frequencies of artifacts with an interleaved scanning and suppresses the artifacts with a band-pass filter. To control the frequencies of artifacts, the relation between the number of interleaves and the frequency of artifacts is formulated, and the number of interleaves is optimized. Furthermore, the method can be easily combined with other methods for dynamic MRI. A simulation model of a heart pulsation showed that the method can successfully suppress streak artifacts.
14:01  **2194. Reduction of Under-Sampling Artifacts in Radial Scanning by Using k-Space-Data Interpolation**

Yo Taniguchi¹, Shinji Kurokawa¹, Hisaaki Ochi¹, Masahiro Takizawa², Tetsuhiko Takahashi²
¹Hitachi, Ltd., Kokubunji, Tokyo, Japan; ²Hitachi Medical Corporation, Kashiwa, Chiba, Japan

A method for interpolating k-space data—which suppresses streak artifacts caused by using under-sampled data during radial scanning—was developed. This method acquires additional reference echoes and uses them to calculate weights for the k-space-data interpolation. Comparing the interpolation results obtained by computer simulation shows that the new interpolation method reduces under-sampling artifacts without loss of spatial resolution.

**Artifacts In and Around the Clinic**

Room 553  Tuesday 13:30 - 15:30

13:30  **2195. Interpolation Artefacts in Non-Rigid Image Registration**

Paul Aljabar⁴, Daniel Rueckert⁴, Jo V. Hajnal⁴
¹Imperial College London, London, UK; ²Hammersmith Hospital, Imperial College London, London, UK

Analysis of transformations generated by high dimensional registration of medical images is an emerging technique. This paper investigates the potential artefacts that can arise in such analysis due to the interaction of different aspects of the registration process. Synthetic images are used to conduct experiments aimed at quantifying these artefacts. Results show that high dimensional registration can compensate for interpolation signal errors by introducing local spatial distortion, and hence volume change. The nature and extent of this behaviour appears determined by the combination of interpolation method, similarity measure and transformation parameters.

13:31  **2196. A Simple Method for Matching Distortions in Functional and Structural Data**

Philip Andrew Boulby⁵, Mark Roger Symms⁵, Gareth John Barker⁵
¹Institute of Neurology, London, UK; ²Institute of Psychiatry, London, UK

fMRI and diffusion tensor imaging typically use EPI to map eloquent areas of the brain. However, the EPI technique usually generates images at low resolution so results are overlaid onto a high resolution “structural” image. EPI however is susceptible to geometric distortions which are greater than those in the structural image. Therefore the activated regions may not be displayed faithfully, resulting in a misrepresentation of results. We propose the use of a high resolution data set with identical geometric distortions to the functional data, so that accurate mapping of activated areas can take place prior to data interpretation.

13:32  **2197. Increased Slice Aliasing Artifacts in MR Ventriculocisternography using 3D SSFP Imaging**

Cheng-Wen Ko¹, Ting-Yi Chen¹, Teng-Yi Huang¹, Yi-Ru Lin¹, Hsiao-Wen Chung¹, Cheng-Yu Chen¹
¹National Sun Yat-Sen University, Kaohsiung, Taiwan; ²Veterans General Hospital, Taipei, Taiwan; ³National Taiwan University, Taipei, Taiwan; ⁴Tri-Service General Hospital, Taipei, Taiwan

The 3D steady-state free precession (SSFP) technique is potentially suitable for MR ventriculocisternography. Imperfect slice profile due to limited time duration of the RF pulse could result in increased slice aliasing artifacts due to accumulation of the low-flip-angle SSFP signal at the boundary slices. Theories and experimental results indicate that the slice aliasing artifacts increase as the designated flip angle increases. Compared with 700, a designated flip angle of 400 reduces the slice aliasing by three-fold at a 32% sacrifice in contrast between CSF and brain parenchyma.

13:33  **2198. Image-Based Ghost Reduction of Amplitude Discontinuities in k-space with Projections Onto Convex Sets (POCS)**

Kuan J. Lee¹, Martyn N. Paley¹, David C. Barber¹, Iain D. Wilkinson¹, Paul D. Griffiths¹
¹University of Sheffield, Sheffield, UK; ²Royal Hallamshire Hospital, Sheffield, Yorkshire, UK

This work examines the use of a POCS algorithm to correct for k-space amplitude discontinuities which give rise to ghosting. Results show that in order for the algorithm to be successful, an a priori model is required to reduce the number of degrees of freedom to approximately 7, equivalent to an 8 interleaved EPI or 8-echo train length FSE image.

13:34  **2199. EEG / EOG - fMRI Cold Head Artifact Removal**

Eric Featherstone¹, Oliver Josephs¹, Ralf Deichmann¹
¹Wellcome Department of Imaging Neuroscience, London, UK

In fMRI studies, it is often desirable to record EEG or EOG data during the scanning process. However, the scanner’s cold-head refrigerant pump often causes problematic interference as eye movement EOG signals and EEG signals are typically obscured by this noise. The interference from the cold-head is repetitive lending itself to being modelled and subtracted from EEG and EOG data. Several techniques have been described such as active noise cancellation or subtraction of mean noise. In this work we describe a new method based on dividing the EEG data into blocks of a suitable length and applying high pass filtering.
13:35 2200. An Algorithm for Moment-Based Global Registration of Echo Planar Diffusion-Weighted Images
Gordon Kindlmann¹, Andrew L. Alexander², Mariana Lazar², Jee Eun Lee², Tolga Tasdizen¹, Ross Whitaker¹
¹University of Utah, Salt Lake City, Utah, USA; ²University of Wisconsin, Madison, Wisconsin, USA

The large gradients used in DW MRI can induce eddy currents that cause distortion and misregistration in EPI. A relatively simple and robust image registration algorithm using the spatial moments of DW image masks was implemented. The algorithm modeled the distortions as a linear function of the diffusion gradient strength. A global warp is estimated for all images simultaneously. After correction using the algorithm, DW images were much better aligned, which reduced artifactual anisotropy at brain edges.

13:36 2201. Correction for Off-Resonance Blurring Improves Spiral Coronary MRA
Tim Leiner¹, George Katsimaglis², Kraig V. Kissinger², Peter Boernert³, Tom Rozijn⁴, Warren J. Manning², René M. Botnar²
¹Maastricht University Hospital, Maastricht, Netherlands; ²Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; ³Philips Research Laboratories, Hamburg, Germany; ⁴Philips Medical Systems, Best, Netherlands

Inhomogeneities in the main magnetic field can produce blurring in images acquired using non-Cartesian k-space readout trajectories. In the current study off-resonance corrected 3D spiral coronary MRA was compared with non-corrected spiral 3D MRA at several different spatial resolutions, and the influence of correction on image quality was investigated in 20 adult subjects. Results showed that correction for off-resonance blurring using CPR is advantageous for spiral coronary MRA because it allows for slightly longer depiction of the main coronary arteries, and it leads to better subjective interpretability.

13:37 2202. Various TR Linear Combination FIESTA on Open MR systems
Aki Yamazaki¹, Mitsuharu Miyoshi¹, Susumu Kosugi¹
¹GE Yokogawa Medical Systems, Hino, Tokyo, Japan

Steady State Free Precession provides strong signal, high contrast images in a short scanning time. However, strong fat signal contaminates image. This paper is to separate fat signal on Open MR system by applying linear combination method.

13:38 2203. Averaging Keyhole Pulse Sequence with Presaturation Pulses and EXORCYCLE Phase Cycling for Dynamic Contrast-Enhanced (DCE) MRI
Hideto Kuribayashi¹, Daniel P. Bradley¹, David R. Checkley¹, Philip L. Worthington¹, Jean J. Tessier¹
¹AstraZeneca, Macclesfield, Cheshire, UK

A keyhole pulse sequence was designed for quantitative 2D DCE-MRI. Presaturation was applied for removing time-of-flight effect. Ghosting artifacts arising by incomplete presaturation were removed by averaging with EXORCYCLE phase cycling. Averaging also improved MRI sensitivity and removed DC offsets. RF spoiling by radiofrequency changing on synthesizer could be combined with EXORCYCLE phase cycling. To reduce intensity difference between pre- and post-contrast, peripheral lines of k-space were updated and interleaved between 7 central lines’ acquisition. Arterial input function was obtained from rat abdominal aorta by this designed keyhole sequence.

Image Processing and Artifact Reduction Methods

Room 553  Tuesday 13:30 - 15:30

13:30 2204. Detection of Corticosteroid-Induced Changes in Thymus: A Comparison between MRI-Evaluated Volume Changes and Wet Weight
K J. Brooks¹, J Hammersley¹, A White¹, S T. Bate², K T. Bunce³, D G. Reid¹, K K. Changani¹
¹GSK, Welwyn, Herts, UK; ²GSK, Harlow, Essex, UK; ³GSK, Stevenage, Herts, UK

Magnetic resonance imaging (MRI) can be used to determine the pharmacological selectivity profiles of particular pharmaceutical compounds such as steroid hormone analogues. These compounds have anti-inflammatory and immunosuppressive qualities and the effectiveness of these compounds can be determined by the degree of thymus involution. Conventional methods of assessing tissue loss such as wet weight analysis require euthanasia of the animal. Here we show that changes in thymus volume measured using MRI is more sensitive than wet weight analysis and can be carried out longitudinally in the same animal thereby reducing the number used in each study.

13:31 2205. The Lagrangian Multiplier Method as a Basis for Elastic Image Registration
Garth M. Beache¹, Nilesh Mistry¹, Bao Zhang¹
¹University of Maryland Medical Center, Baltimore, Maryland, USA

Non-rigid body registration is important for objects that undergo configuration change during observation. Previous non-rigid registration approaches require an arbitrary free parameter. We report on an approach in which the registered state is considered an equilibrium configuration, for all forces acting on the system, and the single parameter is equated with the value of a Lagrangian multiplier (L), that guarantees stability of the system. The boundary constraint energy tends to zero for a unique value of L. The functional dependence of the Lagrange multiplier is shown to be consistent with established optimality criteria.
Nonlinear Point-Based Registration of Mouse Kidney MR Images

Xenophon Papademetris, Pavel Shkarin, Hirohito Okuda, Kevin Behar
1Yale Medical School, New Haven, Connecticut, USA

We present preliminary results from the application of point-based non-linear registration methods on high-field mouse kidney images. The ultimate goal of this work is the construction of a statistical shape atlas for the mouse kidney, a key part of an automated segmentation strategy. We acquire high-resolution in-vivo and postmortem MR image data using the spin-echo technique. The kidneys were segmented interactively, and are aligned into the same space using an extended robust point matching algorithm. The results indicate that the registration is highly accurate. The next step is the acquisition of more data sets and construction of the probabilistic atlas.

Alignment of Ventilation and Perfusion Images at Acquisition: Validation in a Porcine Model

Punam Saha, Binquan Wang, Masaru Ishii, David Lipson, Warren Gefter, Mitchell Schnall, Rahim R. Rizi
1University of Pennsylvania, Philadelphia, Pennsylvania, USA; 2Johns Hopkins University, Baltimore, Maryland, USA

The purpose of this study is to test the hypothesis that, under controlled conditions, it is possible to acquire co-registered ventilation (V) and perfusion (Q) images for quantitative assessment of lung function. Q and V images were acquired in a porcine model under identical imaging conditions. A mutual information based method of rigid body registration was utilized.

A Novel Method for Determining Bone Volume Fraction Using a Local Threshold Criterion

Branimir Vasilic, Felix W. Wehrli
1University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA

Micro-MRI images of trabecular bone can be used to calculate the bone-volume fraction (BVF) which is the ratio of the volume occupied by trabecular bone and the total volume of bone and marrow. To determine the BVF must distinguish between bone and marrow and then correctly estimate the volume of bone in the presence of noise. MRI images are also often shaded due to field inhomogeneity of the receiver coil. We introduce a method that calculates a local image intensity threshold, used to classify pixels into bone or marrow, and effectively deals with the problem of shading.

Semi-Automatic Method for 3D Registration of Trabecular Bone Images in Serial Studies

Branimir Vasilic, Andra Popescu, Benjamin Bunker, Felix W. Wehrli
1University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, USA

MRI images of trabecular bone are a promising source from which structural parameters that characterize bone competency can be calculated. In longitudinal studies volume registration is one of the crucial factors that determine the reproducibility of calculated parameters. Here we present a semi-automated method for volume registration. The method was tested on micro-MRI images of the wrist and ankle in perimenopausal women, acquired at baseline and 1 month. The 1 month retest volumes were registered against the baseline and this information was used to generate volume of interest masks that selected the same analysis volume for both acquisitions.

Left-Right Differences in Knee Cartilage Thickness Using Model-Based Correspondence

Tomos G Tudno Williams, Christopher J. Taylor, John C. Waterton, Andrew Holmes, Anthony F P Nash
1University of Manchester, Manchester, UK; 2AstraZeneca, Macclesfield, Cheshire, UK

We present an aggregate thickness map of the knee cartilage for a group of healthy females. A Minimum Description Length Statistical Shape Model is used to define dense, anatomically equivalent points on the underlying bone surfaces. Cartilage thicknesses, measured at corresponding points, are aggregated and displayed on the mean bone shapes to define the normal range. The cartilage is thickest in the load bearing regions, particularly in the centre of the patellar and medial tibial compartments. Left-Right difference analysis shows that cartilage has a tendency to be significantly thicker at the right edges of both joints.

Rapid Total Body Fat Quantification by Magnetic Resonance Imaging

Armin de Greiff, Florian Vogl, Mark E. Ladd
1University Hospital Essen, Essen, NRW, Germany

Whole body fat content was determined with MRI and compared to impedance measurements and X-Ray Absorptiometry (DEXA). We utilized different acquisition sequences as well as varying segmentation algorithms. Since complex water-fat separation techniques, e.g. the Dixon method are too time consuming we choose a T1-weighted 2D-FLASH sequence and utilized custom made software based on a 3D region growing algorithm with field inhomogeneity correction. Other approaches, e.g. the Fuzzy-K-Mean suffered from signal dropouts. The examinations of 12 healthy subjects were evaluated by two independent readers and fat measurements showed good agreement with the two other methods.
Homogeneous Water-Lipid Phantoms with Matched $T_1$ and $T_2$ Relaxation Times for Quantitative Magnetic Resonance Imaging of Tissue Composition at 3.0 Tesla

Jonathan P. Dyke¹, Antonio Lauto², Erika Schneider³, Cornelia Matei⁴, Josefino Borja¹, Xiangling Mao⁵, Dikoma C. Shungu⁴, Ann Jakubowski⁴, Eric Lis⁴, Doug Ballon¹

¹Weill Cornell Medical College, New York, New York USA; ²University of New South Wales, Sydney, New South Wales, Australia; ³SciTrials, LLC, Westwood, Massachusetts, USA; ⁴Memorial Sloan-Kettering Cancer Center, New York, New York, USA; ⁵Mount Sinai School Medicine, New York, New York, USA

The design of solid two-component phantoms for MR imaging is presented which allows for matching of both spin-lattice and spin-spin water and methylene lipid relaxation times. Water in agarose gel and lipid phantoms with high spatial homogeneity, temporal stability, and controllable water fractions ranging from 0 to 1.0 in 0.1 increments were achieved. Composition comparisons were made using a 3-point Dixon technique as well as a stimulated echo spectroscopic method versus water fractions by weight during manufacture. Less than 5% spatial composition variation and 10% spatial variation in $T_1$ and $T_2$ were observed.

Automated Segmentation of Liver Metastases in Diffusion-Weighted Echoplanar Images using Region Growing and Snakes Based on Fuzzy Sobel Edge Detector

Chetankumar Krishnamurthy¹, Robert Gillies¹, Jeffrey Rodriguez¹

¹The University of Arizona, Tucson, Arizona, USA

This communication presents a novel and robust method for accurate segmentation of lesions in diffusion weighted MR images of liver. This method employs "snakes", also referred to as active contours, the initial contour of which was formed using edge and region information. Deformation of the snake from this initial position was guided by fuzzy edge information. Segmented lesions were compared to radiologist-defined ROIs and were shown to provide an accurate representation of the lesion boundary with few iterations and minimal user interaction.

A Multi-Resolution Adaptive Filtering for Preserving Information in Dynamic Functional Imaging

Dmitri Artemov¹, Arvind P. Pathak¹, Zaver M. Bhuwalia¹

¹Johns Hopkins University, Baltimore, Maryland, USA

The noninvasive, in vivo characterization of the tumor vasculature using dynamic MRI is an indispensable tool in the study of the tumor microenvironment. However, irrespective of the models employed when creating functional maps of the tumor vasculature, we often to lose voxels to noise or to poor fitting. Here we propose an approach wherein, voxels that do not meet the criteria for goodness-of-fit are clustered with those that do, to create a multi-resolution functional map. In such a map, the noisy voxels are rendered with lower spatial resolution, whereas the high resolution is preserved for non-noisy voxels.

A Method for Validation of 3D Nonrigid Image Registration Algorithms

Yi-Yu Chou¹, Oskar Skrinjar¹

¹Georgia Institute of Technology, Atlanta, Georgia, USA

A method for validation of nonrigid 3D image registration algorithms is presented and compared to a manual validation strategy. The method provides pairs of deformed images as well as corresponding true displacement fields with known accuracy. Nonrigid registration algorithms can be run on the pairs of images and their outputs can be compared to the true displacement fields generated manually by five observers. While this phantom validation study does not provide physically correct deformations, it's certainly an useful way to test the algorithm's ability to recover various deformation patterns.

Auto Alignment of Intervertebral Disks

Simone Peschl¹, Thomas Ernst¹, Oliver Speck¹, Jürgen Hennig¹

¹University Freiburg, Freiburg, Germany; ²Brookhaven National Laboratory, Upton, New York, USA

There is a great interest in the automatic prescription of slices for scanning the intervertebral disks these day’s due to the large amount of troubles concerning the spine. With the new approach highly reliable and reproducible double oblique slices are positioned after two prescans without any interaction on the following scan for imaging intervertebral disks or bodies.

Intensity Uniformity Correction by Removing Bias Field with Wavelet Smoothing

Sung Taek Chung¹, Yang Hyun Kim¹, Wan Seok Rya¹, Jung Ho Hyun², Ingi Hong³

¹MEDINUS, Yongin-Si, Kyunggi-Do, Republic of Korea; ²Korea Polytechnic University, Siheung, Kyunggi, Republic of Korea

To correct intensity non-uniformity in MR images, wavelet transform is adopted for smoothing image data in acquiring a bias field. N3 method is introduced for finding bias field by smoothing error data and Gaussian kernel is originally used for smoothing. Wavelet transform has characteristic of separating high and low frequency components of data. Therefore to reserve high frequency components of image unchanged wavelet transform(Daubechies, D4) is used for smoothing instead of Gaussian kernel. Not much damage on image shape and better uniformity, higher SNR were observed by the result.
13:44 2218. **Trilateral Filtering: A Non-linear Noise Reduction Technique for MRI**

*Wilbur C. K. Wong*, *Albert C. S. Chung*

1Hong Kong University of Science and Technology, Hong Kong, Hong Kong

Filtering is a preliminary process in many medical image processing applications. Post-processing tasks, e.g., visualization, segmentation and quantification, may benefit from the reduction of noise. In this paper, we present a novel filtering method, integrating geometric, photometric and local structural similarities, to achieve edge-preserving smoothing in medical images. It is simple to implement and is applicable to multi-dimensional signals. The experimental results have shown that this new technique is capable to smooth MRI images while preserving the edges. It provides a more than satisfactory image restoration as compared to other noise reduction methods.


*Zili Chu*, *Zhiyue J. Wang*

1Baylor College of Medicine, Houston, Texas, USA

Determination of the centerline is the key step in mathematical modeling of the blood vessels. We propose a novel semi-automatic centerline-extraction method, which is based on 3D Gaussian least squares fit of the vessel to a rod shaped object in a spherical volume. It allows accurate determination of the local orientation of the blood vessels. The features of this method are the simplicity and easiness for implementation. Our study shows that this method can accurately extract centerline from an angiogram image with high noise level.

13:46 2220. **Artery-Vein Separation For Vessel Analysis**

*Huseyin Tek*, *James P. Williams*

1Siemens Corporate Research, Princeton, New Jersey, USA

The MS-325 contrast agent for MRA remains in the bloodstream for longer periods of time, thus allowing acquisition of high spatial resolution imaging of arteries and veins. However, the enhancement of venous structures often makes the visualization and quantification of arteries rather difficult task for the radiologists. Thus, the arteries need to be segmented and separated from venous structures. A new algorithm which combines region based deformable models with the vessel centerline models is presented for the separation of arteries from veins in CE-MRA We have successfully tested our algorithm on more than 20 abdominal CE-MRA data sets.

13:47 2221. **Magnetic Resonance Imaging of a Magnetic Field Generated by Electric Current Based on a Shift in the Resonant Frequency**

*Masaki Sekino*, *Tatsuki Matsumoto*, *Kikuo Yamaguchi*, *Norio Irguchi*, *Shoogo Ueno*

1University of Tokyo, Tokyo, Japan; 2University of Kumamoto, Kumamoto, Japan

We propose a method of detecting electric currents using MRI. The motion of magnetization during applications of electric currents and radiofrequency (RF) pulses was formulated based on the rotating-frame Bloch equation. The relationship between a magnetic field generated by an electric current and the signal intensity of an image was calculated for a Gaussian RF pulse with a duration of 10 ms. Images of a spherical phantom were obtained with and without application of an electric current to a straight wire. The magnetic field measured from the images was found to be in agreement with the theoretically calculated magnetic field.

13:48 2222. **Detection of Weak Magnetic Fields Induced by Electrical Currents Using MRI: Theoretical Sensitivity Limits and Related Experiments**

*Tomohisa Hatada*, *Masaki Sekino*, *Shoogo Ueno*

1University of Tokyo, Bunkyo-ku, Tokyo, Japan

Detection of weak magnetic fields induced by electrical currents is necessary for the mapping of neuronal electrical activities in the brain. In this study, we analyzed the theoretical sensitivity limits of magnetic field strength change from the gradient echo (GE) phase image by computing the theoretical value of signal and noise. We also performed related experiments. In the case of the columnar phantom injected with a pulsed electrical current, the theoretical limit was $10^{-7}$ T and the experimental limit was $10^{-8}$ T. The variance in the theoretical limits of the detectable change in magnetic field strength was computed by modifying the parameters.

13:49 2223. **Non-Homogeneous Wavelet Denoising**

*Sinita Pajevic*, *Gustavo K. Rohde*, *Peter J. Basser*, *Akram Aldroubi*

1National Institutes of Health, Bethesda, Maryland, USA; 2Vanderbilt University, Nashville, Tennessee, USA

Wavelet denoising has been successfully used in variety of signal and image processing problems. In all applications that we are aware of, it is assumed that the noise is independent and identically distributed. Here we extend that framework to the situations where the noise is not identically distributed, i.e., it is spatially inhomogeneous. To do this we use a hypothesis testing framework and show its advantages over standard wavelet shrinkage. We also discuss its applications to DT-MRI.
13:50  2224.  Quantification of Field Changes due to Tissue Susceptibility Variations
Yu-Chung Norman Cheng1, E. Mark Haacke2, Robert W. Brown1
1Case Western Reserve University, Cleveland, Ohio, USA; 2440 E. Ferry St. Unit 2, Detroit, Michigan, USA

The emergence of MRI susceptibility weighting leads to the need for quantifying susceptibilities from different sources. We summarize the results of a theoretical derivation of induced fields due to susceptibilities of different tissues immersed in a homogeneous field. Where there is common ground, our work is consistent with the expressions found in an interesting recent publication by Li. Based on his experimental data, we also have a good agreement with his estimate of the susceptibility difference between two liquid solutions. Furthermore, we can compute the susceptibility of Li’s doped water solution, finding the value of -8.22 ppm.

13:51  2225.  Genealogy: a Method to Prevent Spikes and Ill-Conditioning in Fast Space-Domain Parallel MRI
Molly Scheffe1, Gary P. Zientara1
1Brigham & Women's Hospital, Boston, Massachusetts, USA

Spiky noise and ill-conditioning are serious problems in space-domain MR reconstructions such as SENSE, which are based on fast (undersampled) multiple-coil data acquisitions. This paper demonstrates that these problems can arise when the aliasing process mixes higher-quality patient data (foreground = signal region) with low-quality background data (noise-only region). This problem can be solved simply by eliminating the background variables from the reconstruction equations at each pixel, resulting in a much more stable and higher-contrast output. The numerical condition number for this revised reconstruction technique can show an improvement by several orders of magnitude over naïve least-squares reconstruction.

Daniel Aaron Moses1, Vitaly J. Napadow2, Richard J. Gilbert3, Qun Chen1
1NYU School of Medicine, New York, USA; 2Massachusetts General Hospital, Boston, Massachusetts, USA; 3Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

A method is described for tracking, over time, the intersection points of SPAMM grid tagged data. This involves constructing maximum and minimum cross filters, each of which depend on two subsets, one oriented in the direction of the horizontal tags and the other in the direction of the vertical tags. The filters are applied to the image at each phase producing tag enhancement and intersection point detection. The method is adaptive in that it uses the previous intersection points to approximate tag orientations in the current phase. The technique is applied to a study of the lung and worked effectively.

13:53  2227.  Using a Least-Square Sense Error Minimization Approach in the Determination of Ferric Ion Diffusion Coefficient in MRI-Fricke-Infused Dosimeter Gels
Yin-Jiun Tseng1, Sung-Cheng Huang2, Woei-Chyn Chu1
1National Yang-Ming University, Taipei, Taiwan; 2UCLA School of Medicine, Los Angeles, California, USA

A least-square sense error minimization approach and fast MR acquisition technique were adopted to calculate ferric ion diffusion coefficient of Fricke-agarose gels. Our results showed that for a Fricke-agarose gel contained 1mM ammonium ferrous sulfate, 1% agarose, 1mM sodium chloride and 50mM sulfuric acid, its ferric ion diffusion coefficient is 1.73 x10-2 cm²·h⁻¹ in room temperature which falls within the 1.00 ~ 2.00 x10-2 cm²·h⁻¹ range previously reported under varying gelling ingredients and concentrations.

Brain Image Processing Methods
Room 553  Monday 14:00 - 16:00

14:00  2228.  Automated Cerebellum Segmentation Based on Knowledge Guided Active Contour in T₁-Weighted MR Images
Zuyao Shan1, Qing Ji1, Amar Gajjar1, Wilburn E. Reddick1
1St. Jude Children's Research Hospital, Memphis, Tennessee, USA

An automated method has been developed to identify the cerebellum from MR brain images. The algorithm combined advantages of registration-based and knowledge-based brain segmentation methods by using a template that was constructed from ten aligned MR head images as an initiation, then actively adjusted to locate the cerebellum boundaries of the given patient. The method was evaluated by another 20 patient data sets. Great Jaccard similarities and kappa indices and strong correlations were found between the manual and automated results.

14:01  2229.  Brain Segmentation Based On Multi-Spectral And Corrected Gray-Scale Analysis
Jinghua Wang1, Maolin Qiu1, Xenios Papademetris1, R Todd Constable1
1Yale University, New Haven, Connecticut, USA

This work describes an automated segmentation method based on in vivo corrected multi-spectrum MRI datasets. By optimized TR and inversion recovery time TI, contrast among brain tissues and SNR are optimized to separate CSF, WM and GM in multi-spectrum MRI data sets. Signal intensity inhomogeneities are corrected using transmission and reception maps obtained in vivo. The three-Gaussian distribution model is used to fit histogram of the images to find the initialization parameters for Expectation-Maximization (EM) algorithm. Finally, the brain tissues are classified by EM algorithm.
A method that considerably reduces the computational and memory complexities that are associated with the generation of high dimensional (≥4) feature maps for image segmentation is described. The method is based on K-nearest neighbor (KNN) classification, which consists of two parts: 1) preprocessing of feature space and 2) fast KNN. This technique has been applied for segmenting MR images, based on four echoes, of multiple sclerosis brains.

To overcome the B1 inhomogeneities of high-field MR images, we present an algorithm that can learn and recognize already-segmented WM, GM and CSF provided by radiologists, and then adapt the learned information to the sequential MR brain images of slowly varying contours. The algorithm consists of a modified k-mean clustering method learning the class probability distribution mixture mean vectors from the already-segmented regions, and a Markov Random Field method applying the learned information to the original and sequential brain images for verification and confirmation. Furthermore, an adaptive algorithm is also provided for automatically updating its knowledge from the learning process.

Neuroscience, disease progression and clinical trial studies, using MRI and other imaging modalities, benefit from unbiased and repeatable image feature quantitation. We describe a general method for segmentation of 2-D imagery that reduces the burden of manual region of interest selection while increasing repeatability. The method uses objective edge definition and edge linking criteria to over-segment an image, and hierarchical clustering of the resulting elemental segments. The rules that define the hierarchical clustering can be modified to suit the segmentation task. The algorithms have been tested on a range of imagery, and are suitable for several MRI tissue segmentation purposes.

Inflation to 3D smooth surface and flattening to 3D sphere or 2D plane are widely used to view the buried sulci of cerebral cortex. This paper proposes a method that reduces self-intersections resulted from conventional parametric deformable model with reasonable computation time. The sphere model is deformed to the segmented white matter(WM) and gray matter(GM) boundary. The proposed method has two-step approach. Step1 generates smoothed WM/GM boundaries. In Step2, vertices of sphere are deformed to the smoothed WM/GM boundaries in inverse order. The Step2 uses multi-resolution approach for deep concave region to be considered as shallow region in low-resolution.

Many atlases are prepared in graphics packages, which depict regions as independent entities. Unfortunately, the drawings are not numerically coherent. This paper presents enhancements to such atlases via an automatic conversion of graphics information into numerically robust delineations. Anomalies such as overlapping lines, open-ended loops, multiple boundary specifications, etc. are eliminated. Atlas labels are used as seed points to form numerically intact ROIs. These 2D modified slices are passed to a multiple-material marching cube algorithm. The output is a fully segmented 3D volume of each individual ROI without overlaps or voids. All internal material boundaries are preserved with fidelity.

In this study a new method is presented for fully automated segmentation of white matter lesions on cranial MRI, based on a supervised KNN-classification technique using multi-spectral information. The algorithm uses for each voxel the spatial coordinates and the gray value of five MRI-scans (T1, T2 and PD-weighted, IR and FLAIR) as features. The results were evaluated both on the basis of binary as well as probabilistic measures. Evaluation showed that the presented method performs the segmentation task with a high accuracy. Furthermore, the method produces a probability map that contains more valuable information than a binary segmentation.
Reproducible inter-exam slice positioning was attained by calculating translations and rotations with cross-correlation of the localizer images of the pre- and post experiments. These fine structures were at most three pixels and similar patterns are also observed on the images, a continuous image is defined based on the discrete image and measurements of the structures are carried out on the continuous image.

Recently, the white matter medullary arteries have attracted attention in connection with linear hyperintensities on T2-weighted magnetic resonance (MR) images. These linear hyperintensities have a potential to be an indicator of hypertensive small vessel disease. This report describes the first trial to detect these fine structures. Since their width is at most three pixels and similar patterns are also observed on the images, a continuous image is defined based on the discrete image and measurements of the structures are carried out on the continuous image.

High-resolution magnetic resonance images of a fixed human hemisphere were obtained. Images with isotropic resolution of 300 microns permitted visual delineation of deep brain structures, such as thalamic nuclei, the quadrigeminal plate, basal ganglia, and others. Classification of four thalamic nuclei was evaluated quantitatively using scatter plots and a Fisher linear discriminant based on intensity information alone and on intensity combined with image location. Delineation of nuclei based on intensity alone results in a high rate of misclassification; however, when spatial location is also considered, the rate of misclassification drops considerably.

This study aimed at obtaining high resolution 3D brain images with optimized grey-white matter contrast based on T1 differences. Simulations and experiments were performed using pulse sequences with multiple inversions and variable flip-angle acquisitions. As a result of parameter optimization, by means of simulated annealing, a five-pulse sequence with 3 image acquisitions was developed. The sequence was evaluated in using high resolution EPI at 3.0T.

An image registration based approach is proposed to construct a white matter atlas using diffusion tensor imaging (DTI). Two 3D B-spline models were used to characterize the forward and backward transformations between the image pair to be registered. These two models were deformed simultaneously to minimize a cost function, which takes into account the similarities of fractional anisotropy (FA) and DT matrices (eigen-values and eigen-vectors) between the image pair as well as the regularization and consistency of the bidirectional transformations. A white matter atlas was built from 10 healthy human volunteers with the proposed approach.
2243. Accuracy and Repeatability of Automatic Slice Positioning Compared with Manual Slice Positioning

Thomas Benner1, Jonathan J. Wisco1, André van der Kouwe1, Bruce Fischl2, A. Gregory Sorensen2
1Athinoula A. Martinos Center, Charlestown, Massachusetts, USA

Accurate and consistent slice prescription can be of great benefit in routine clinical practice. The accuracy and repeatability of a previously described method for automatic slice prescription based on a statistical atlas of the brain was compared to that of manual slice positioning. Subjects were repeatedly scanned using manual and automatic prescription. Follow-up images were co-registered to the initial scan and registration errors were calculated. Variation of co-registration parameters was significantly larger for manual prescription. Co-registration improved image alignment for manual prescription but did not improve alignment for automatic prescription. The method studied proved to be accurate and reliable.

2244. MR Image Guided 3D Registration and Mesh Generation for Brain Vasculature Model

James Q. Zhang1, John M. Sullivan, Jr.1, Hamid R. Ghadyani1, Udo Benz2, Ziji Wu3, Donna M. Meyer3
1Worcester Polytechnic Institute, Worcester, Massachusetts, USA; 2Dartmouth College, Hanover, New Hampshire, USA; 3University of Rhode Island, Kingston, USA

A robust approach for 3D mesh generation guided by MR brain image datasets is introduced to generate vasculature models. The topologic relationship of the brain anatomy is extracted from MR images through interactive segmentation processes. A working scheme combining image registration techniques with a digital brain atlas is developed to reduce model preparation time. In this approach an innovated deltalized building block strategy is used. It creates multiple-material volumes which preserve the brain region delineations with fidelity while producing a high quality, integrated volume mesh suitable for numerical computation. Results are presented demonstrating the high quality volume mesh models.

Parallel Imaging

Room 554  Monday 14:00 - 16:00

14:00 2245. Efficient 3D SPACE-RIP

W Scott Hoge1, Lei Zhao1, Walid Kyriakos1
1Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA

A computationally efficient Space-RIP implementation for 3D parallel imaging is presented, which employs irregular sampling along one phase-encode dimension, and uniform downsampling along a second. This choice of phase encodes enables a reconstruction algorithm that requires significantly less memory to compute than general reconstruction methods, is computationally competitive with 2D SENSE, and allows greater control in suppressing aliasing artifacts. The technique is demonstrated with 3D FSE neural images.

14:01 2246. Parallel Imaging with 3D PR(VIPR)

A. Arunachalam1, A. Lu1, E. Brodsky1, S. Fain1, W. F. Block1
1University of Wisconsin-Madison, Madison, Wisconsin, USA

We investigate adoption of parallel imaging methods in 3D PR to reduce the loss in CNR introduced by undersampling artifacts. The advantages of parallel imaging for 3D PR is demonstrated with the application of the conjugate gradient reconstruction method to a 3D VIPR trajectory that reconstructs a spherical FOV with 256*256*256 resolution. Significant decreases in the level of the structured background noise and the corresponding improvement in contrast are demonstrated.

14:02 2247. UNFOLD-SENSE Accelerated SSFP Cine Cardiac Imaging: Correlation of LV Volumetric Measurements with Conventional SSFP Cine

Tarang N. Sheth1, Bruno Madore1, Robert Mulkern1, Marcus Averbach1, Raymond Kwong1, Frank Rybicki1, E. Kent Yucel1
1Brigham and WOMEN's Hospital, Boston, Massachusetts, USA

UNFOLD-SENSE is a parallel imaging method with artifact suppression designed to produce high-quality, rapid clinical scanning. We evaluated UNFOLD-SENSE SSFP cine implemented with an acceleration factor of 2.5 to shorten breathhold duration in clinical cardiac imaging. Assessment of LV volumes and function obtained with UNFOLD-SENSE and conventional SSFP cine were quantitatively equivalent, supporting the potential for UNFOLD-SENSE to be of benefit in the clinical evaluation of patients when shorter breathholds or faster scanning is required.

14:03 2248. A Parallel Image Reconstruction for Real-Time MRI: Neither SMASH nor SENSE

Sven Mueller1, Wolfhard Semmler2, Michael Bock2
1Deutsches Krebsforschungszentrum, Heidelberg, Germany

A reconstruction algorithm for parallel MRI is presented, which is optimal in the least-squares sense. The algorithm is designed for real-time reconstructions and can operate on successive k-lines during image acquisition. Compared to SMASH, individual measured k-lines are not only used to reconstruct neighboring lines but the complete k-space. The algorithm provides results that are identical to a SENSE reconstruction, however, a continuous data reconstruction is possible, which makes more effective use of the reconstruction processor.
14:04  2249. Massively Accelerated Comprehensive Volumetric Body Imaging Examinations with a 32-Channel MR-System
Thoralf Niendorf1, Daniel K. Sodickson2, Charles A. McKenzie2, Norman Farrar2, Christopher J. Hardy3, Yudong Zhu4, Giontran Kenwood4, Michael J. Harsh4, Neil M. Rosky2
1GE Medical Systems, Boston, Massachusetts, USA; 2Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA; 3GE Global Research Center, Niskayuna, New York, USA; 4GE Medical Systems, Waukesha, Wisconsin, USA

Eight- to sixteen-fold accelerations have been achieved using parallel imaging in conjunction with 3D T1- and T2-weighted abdominal imaging using a true 32-channel system together with a 32-element coil array. This allows full volumetric coverage of the liver while maintaining a high in-plane spatial resolution without exceeding clinically acceptable breath-hold times. Our results indicate that highly accelerated contrast-enhanced T1-weighted studies are particularly promising due to the increased contrast-to-noise ratio and offer the potential for volumetric coverage and speed of multi-detector CT while preserving the inherent contrast mechanisms associated with MRI.

14:05  2250. Reduction of Magnetic Field Inhomogeneity Artifacts in EPI with SENSE-GESEPI
Qing X. Yang1, Michael B. Smith1, Jianli Wang1, Xiaoyu Sun1, Mark Meadowcroft1, Paul Eslinger1, Peter M. van Jijl2, Xavier Golay2
1Penn State College of Medicine, Hershey, Pennsylvania, USA; 2Johns Hopkins University, Baltimore, Maryland, USA

With the SENSE technique, the EPI geometric distortion artifact by in-plane local gradients is reduced while the signal-loss and blurring artifacts remain prominent. The GESEPI method is effective in reducing signal-loss artifacts caused by through-plane local gradient but with increased acquisition time. Combining the SENSE with the GESEPI yields a complementary method effective in reduction of all three types of EPI artifact for rapid T2* acquisition.

14:06  2251. Single-Shot STEAM MRI Combined with SENSE
Jürgen Finsterbusch1, Martin A. Koch1
1Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany

The SNR in single-shot STEAM is limited by the flip angle of the read-out RF excitation that depends on the desired resolution and the FOV in phase-encoding direction. Combining single-shot STEAM with SENSE allows to reduce the FOV in phase-encoding direction without aliasing. Thus, the read-out flip angle can be increased and the corresponding SENSE gain compensates the loss related to the FOV reduction and to some extent also that introduced by the geometry factor. As a consequence, single-shot STEAM MRI can be performed with considerably shorter acquisition times at the expense of only a minor SNR penalty.

14:07  2252. Single Breath-Hold Whole-Heart Inner Volume Black-Blood Cardiac MRI using SSFSE with Parallel Imaging
Belinda S.Y. Li1, Anasuya Mohan Rao2, Wei Li1, Robert R. Edelman3, Jason A. Polzin4
1GE Medical Systems, Evanston, Illinois, USA; 2GE Medical Systems, Bangalore, India; 3GE Medical Systems, Waukesha, Wisconsin, USA

Conventional black-blood cardiac imaging uses segmented fast spin echo (FSE), acquiring 1-2 slices per breath-hold, resulting in prolonged examination and patient discomfort when 8-10 slices to cover the whole heart are needed. The use of half-Fourier single-shot FSE (SSFSE) substantially shortens scan time, but its long echo train length (ETL) results in image blurring. Here, inner volume together with parallel imaging was applied to black-blood SSFSE, significantly reducing ETL for a given spatial resolution and/or improving spatial resolution for a fixed ETL. Good quality whole heart black blood images could therefore be obtained in a comfortable single 15-20 sec. breath-hold.

14:08  2253. Phase Sensitive SSFP Parallel Imaging
Shreyas S. Vasarawala1, Brian A. Hargreaves1, Dwight G. Nishimura1
1Stanford University, Stanford, California, USA

Two avenues of recent progress in rapid MRI are balanced steady-state free precession imaging (SSFP, True-FISP, FIESTA, balanced FFE) and parallel imaging (SMASH, SENSE). This work introduces a novel combination of PS-SSFP and SENSE for ultrarapid fat-suppressed 3D imaging. As with the SENSE technique, aliased high-resolution SSFP images from an array of coils are obtained along with low-resolution reference image. A nonaliased high-resolution complex-valued image is reconstructed and partitioned into water and fat images based on the phase transition of the MR signal. Excellent fat suppression is demonstrated in phantoms and in vivo.

ESR Imaging
Room 554  Monday 14:00 - 16:00

14:00  2254. Changes in the Tumor Microenvironment Early After Irradiation: An EPR Oximetry Study
Nathalie Crokart1, Bénédicte Jordan1, Nelson Beghein1, Olivier Feron1, Réginald Ansiaux1, Bernard Galiez1
1Catholic University of Louvain, Brussels, Belgium

We observed a significant increase in the pO2 in two types of tumor models early after irradiation (maximal pO2 observed at 4 hours). This increase in pO2 is correlated with a decrease in tumor interstitial fluid pressure and an increase in tumor perfusion.
14:01 2255. Regulation of Plasma and Tissue Concentration of a Spin Probe, Oxo63, for pO2 Mapping in Mice
Ken-ichiro Matsumoto¹, Sean English¹, Ken-ichi Yamada¹, Aravalluvan Thirumaran¹, Nallathamby Devasahayam¹, John A. Cook¹, James B. Mitchell¹, Sankaran Subramanian¹, Murali C. Krishna¹
¹National Institutes of Health, Bethesda, Maryland, USA

The in vivo pharmacokinetics of the spin probe, Oxo63, after bolus and/or continuous intravenous infusion was investigated in C3H mice to determine a suitable dose of Oxo63 for Electron Paramagnetic Resonance (EPR) based oxygen mapping. Steady blood and tissue concentration of Oxo63 will lead to reliable quantification of pO2 by Continuous Wave (CW) / time-domain Electron Paramagnetic Resonance Imaging (EPRI) and Overhauser-enhanced MRI (OMRI). The goal was to attain stable tissue Oxo63 concentration at optimal levels for quantitative oxygen mapping. Continuous infusion following a bolus injection was found to be effective to obtain stable plasma concentration and image intensity.

14:02 2256. Resolution of Heterogeneity of Oxygen in Tissues Using EPR Oximetry with Particulates
Benjamin B. Williams¹, Oleg Y. Grinberg², Eugene Demidenko³, Harold M. Swartz⁴
¹Dartmouth Medical School, Hanover, New Hampshire, USA

It had been thought that in vivo EPR oximetry based on particulates has an inherent limitation in resolving heterogeneity related to the size of the particles and the distance between particles. Using appropriate magnetic field gradients and algorithms, however, spectra reflecting the average partial pressure of oxygen at several sides of the same particle can be resolved. Using multisite EPR oximetry at least 6 sites can be resolved within a one cm sphere; therefore 36 independent measurements of oxygen can be made. In addition, using appropriate line shape analysis, the extent of heterogeneity within each spectrum can be determined.

Brain MR Spectroscopy: Methods and Models
Room 554  Tuesday 13:30 - 15:30

13:30 2257. An Approach for Absolute Quantification of Single Voxel MR Spectroscopy with Receive-Only Head Coils
Gregor Jost¹, Inga Harting¹, Sabine Heiland¹
¹University of Heidelberg Medical Center, Heidelberg, Germany

Absolute quantification of MR spectra requires signal calibration as well as correction for variable coil load and inhomogeneities of the local B1 field. Solutions for quantification that have been presented so far rely on the use of transmit-receive coils. In neuroradiology however, receive-only head coils are widely used. We therefore developed a method for the correction of differences in coil sensitivity and B1 field inhomogeneities of stimulated echo acquisition mode single voxel MR spectroscopy. This requires the acquisition of 10 additional spectra without water suppression with an total scan time of 60 seconds in vivo.

13:31 2258. Phase Correction for Eight-Channel Head Coil in MR Spectroscopy
R. Irwan¹, P. E. Sijens¹, P. Kappert¹, W. Tamminga¹, J.A. van der Veen¹, M. Greuter¹, M. Oudkerk¹
¹Groningen University Hospital, Groningen, Netherlands

An eight-channel head coil has recently been introduced in MRI to increase SNR. A gain in SNR is achieved in MRI as only magnitudes need to be added up. Adding up the eight signals in MRS, which for well-resolved spectra requires the real parts, has not been reported yet. Phase shifts among the channels should be corrected first before the summation. In this abstract, we propose a method for phase correction, and the summation of the eight signals for MRS. In terms of SNR this method yields a gain of approximately 4 dB.

13:32 2259. Simple Absolute Signal Scaling for Spectroscopic Data Acquired with Phased-Array Coils at 1.5T
Timo Schirmer¹, Susan Kohler², David Gultekin², Thomas Raedy¹
¹GE Medical Systems, Hallbergmoos, Germany; ²GE Medical Systems, Waukesha, Wisconsin, USA; ³Duke University Medical Center, Durham, North Carolina, USA

Quantitative analysis of single voxel spectra has become a standard, which can be achieved with reasonable efforts using commercially available programs like the LCModel. For surface or phased-array coils with spatially varying B1 sensitivity, absolute quantification is more difficult, as signal and metabolite concentrations are not directly proportional to each other. This study will introduce a method to scale single voxel spectra using the unsuppressed water signal acquired with the B1 insensitive body coil as a reference signal. It will be shown in phantom experiments, that the unsuppressed water signal can reliably be acquired with the body coil.
Single-voxel proton magnetic resonance spectroscopy (MRS) is typically used in a clinical setting to quantify metabolites from a region of interest located in the human brain. Using multiple receive channels, an absorption spectrum from each channel can be generated; however interpreting the results from each channel is a tedious process. A new algorithm is introduced that uses a reference-weighted spectrum averaging technique to combine absorption spectra from multiple channels into a combined spectrum. The combined absorption spectrum obtained from multiple receive coils is similar to the absorption spectrum obtained from a single-channel quadrature head coil and is clinically acceptable.

This work presents the results of a systematic and quantitative comparison of methods from pattern recognition for the analysis of magnetic resonance spectra. The medical question addressed in this study is the classification of cerebral neoplasm after radiotherapy. Our optimal classification method gives predictions with a reliability that is 22% higher than the published state of the art.

Heterogeneity of tissue composition in region of interest (ROI) may cause inaccuracy in the quantitative analysis of MRS data. The presented approach was based on a general linear model using tissue composition as a covariate, and was applied clinically for the investigation of age-related changes and gender differences in the cerebral metabolite concentrations. Spectra were acquired from four ROIs in the gray matter and the white matter of each of the 77 healthy subjects (range 22-76 years old). The results showed age-related changes and gender differences in the concentration of cerebral metabolites with different spatial distributions.

A tool has been developed that allows for rapid interactive spectral modeling of in vivo spectra. Besides interactive spectral modeling, the application allows for easy build up and maintenance of metabolite prior knowledge databases. The application allows for direct loading of Dicom files that contain spectral data. Quantified spectral data can be viewed together with MRI images, allowing for a combined study (off line) of MRS data together with MRI data.

High-resolution MRS is a powerful tool for the study of molecular structures and in vivo metabolites. However, environmental variations may produce spurious field gradients that broaden resonance lines and hide fine spectral features. In this abstract, two modified CRAZED sequences for intermolecular multiple-quantum coherences (iMQCs) were designed to obtain high-resolution NR in inhomogeneous fields, and a fast and efficient numerical algorithm was employed to simulate iDQC behavior. The results show that iDQCs can significantly narrow the line-width under inhomogeneous fields while all the important information including chemical shifts, J-couplings, multiplet patterns, and relative signal intensities are well retained.

We have extended the discussion of intermolecular multiple-quantum coherences (iMQCs) from time domain to frequency domain and developed a full expression to describe the signals originated from iMQCs for the first time. Linewidth and phase of the signal were investigated in detail under linear approximation. For the iMQC signals of different coherence orders, Fourier transformations of FID no longer result in Lorentizian or Gaussian lineshapes, but particular lineshapes distorted by an oscillating cosine term. The resonance line profiles presented here show a good coincidence with numerically simulated data.
13:39  **2266. Comparison of Methods for Quantitative In-Vivo 31P and 1H MRS in Human Brain**

*Reto Buchli*, *Rolf Schaeren*, *Markus Scheidegger*, *Peter Boesiger*, *Urs Boutellier*

*1University of Applied Sciences, Northwestern Switzerland, Baden, Aargau, Switzerland; 2Swiss Federal Institute of Technology, Zurich, Switzerland*

Three calibration methods were tested to quantify in-vivo metabolite concentrations in healthy human brain. The internal water of tissue was used as homonuclear or heteronuclear internal standards in 1H and 31P MRS, respectively. A reference bottle placed on top of the head or a replacement phantom, measured instead of the head, were both used as homonuclear external standards. The smallest errors were made with the replacement-phantom method (1H=8%; 31P=7%) and the internal-water method for 1H MRS (1H=11%). The internal-water method is not recommended for 31P and the reference-bottle method proved to be relatively inaccurate.

13:40  **2267. Single versus Double Inversion Recovery Techniques for Nulling of Low Molecular Weight Metabolites in In Vivo 1H MRS of the Brain in 1.5 and 3.0 T Magnetic Fields**

*Zenon Starcuk Jr.*, *Jana Starcukova*, *Vladimir Mlynarik*, *Jaroslav Horky*, *Ewald Moser*, *Zenon Starcuk*

*1Academy of Sciences of the Czech Republic, Brno, Czech Republic; 2University of Vienna, Wien, Austria*

Adequate measurement of in vivo 1H MR spectra of macromolecules (proteins, lipids) in the brain requires effective suppression of considerably stronger signals of low molecular weight metabolites, whose T1 and T2 relaxation times are fairly inhomogeneous. Schemes with single or double inversion recovery are most often employed for this purpose, exploiting the differences of T1 relaxation times of macromolecules and metabolites. In this paper, properties of these schemes are compared, mainly with respect to the efficiency of metabolite suppression and macromolecule detection. Additionally, problems of incorporating highly effective B1-, T1- and B0-insensitive water suppression are dealt with.


*Astrid Stengel*, *Tobias Neumann-Haefelin*, *Friedhelm Zanella*, *Heinrich Lanfermann*, *Ulrich Pilatus*

*1J.W. Goethe University, Frankfurt am Main, Germany*

In several studies at short TE large scattering of the Glu+Gln(Glx) data was observed, which may be attributed to a low SNR and baseline distortions. Here we present data from a phantom study (TE=30ms), which demonstrate that the signal pattern / intensity of coupled spin systems like Glu and Asp depend on voxel size and shape. Signal variations up to 100% were detected, while only minor effects could be observed for formic acid (+/- 11%). In conclusion, analysis of short TE spectra using prior knowledge obtained from model spectra can be affected by the shape of the examined volume.

13:42  **2269. The Variation of In Vivo 31P Brain MRS Measurements Due to Analysis Technique**


*1Hammersmith Hospital, Imperial College London, London, UK*

31P MR spectroscopy allows the monitoring of intracellular pH. To investigate the most robust method of measuring the pH in vivo, 31P brain MR spectra were analysed by three different techniques. It was found that the different techniques produced differing values of the pH and that manually measuring the pH produced a less variable value than that produced by the other analysis methods. The differing values produced by the differing analysis techniques may explain variations in pH values reported in previous studies.

13:43  **2270. Metabolite Quantitation from MRSI Data Employing a Novel Tissue Segmentation Method**

*Peter Vermathen*, *Chris Boesch*, *Roland Kreis*

*1University & Inselspital, Berne, Switzerland*

A novel tissue segmentation method is presented to correct MRSI data for CSF voxel contributions. The method employs multi-compartment fitting of water components in voxels at the resolution of the MRSI measurement and thus yields contributions of GM WM, and CSF for each pixel. A modified IR-Fast-Spin-Echo sequence was used to acquire 180 intensity values with different combinations of TE and TI for each pixel. Results of six MRSI measurements showed significantly lower Cr in pure white than in gray matter, while NAA and Ch were not significantly different. The method proved robust, metabolite concentrations were similar to literature values.

13:44  **2271. A Phantom for Quantitative Fat Imaging**

*Scott D. Swanson*, *Vikas Gulani*, *Hero Hussain*, *Tom Chenevert*

*1University of Michigan, Ann Arbor, Michigan, USA*

Quantitative fat imaging is becoming important for diagnosis of diseases such non-alcoholic fatty liver disease. We propose a new type of homogeneous fat phantom that allows creation of any desired fat concentration, from 0% fat to 100% fat. The phantom is made with aqueous solutions of the surfactant sodium dodecyl sulphate (SDS). SDS concentration is held constant and the concentration of water protons is varied by changing the ratio of H2O to D2O. This phantom provides the means to quantitatively test the validity of MRI measure of percent fat content.
13:45 2272. Effect of Glutamine/Glutamate Increase on the N-acetylaspartate Quantification in Patients with Hepatic Encephalopathy Assessed by $^1$H-MRS
Valeria Clementi 1, Stefano Iotti 1, Emil Malucelli 1, Caterina Tonon 1, Raffaele Lodì 1, Bruno Barbironi 1
1Università di Bologna, Bologna, Italy

β-γ-Glx resonances partially overlap the resonance of methyl-NAA, thus interfering with NAA quantification. We evaluated NAA overestimation due to β-γ-Glx peaks in model solutions containing NAA and Glx in variable amounts and ratios, in ten healthy volunteers and six patients with different degrees of hepatic encephalopathy. NAA overestimation in healthy controls was comparable with data obtained from model solutions, while in patients was smaller, although they showed higher Glx content.

13:46 2273. NOE Enhancements of Phosphorylated Metabolites in Human Brain at 1.5T
Mark Julius Albers 1, Mavin D. Nelson 1, Stefan Bluml 1
1Children's Hospital-Los Angeles, Los Angeles, California, USA

The Nuclear Overhauser effect (NOE) enhancement due to proton spin saturation in proton-decoupled 31P MRS is different for different metabolites. Thus, the determination of NOE is important for accurate quantitation of spectra and interpretation of peak ratios in normal and diseased brain. Conventional and proton-decoupled 31P MR spectra were acquired in 15 subjects at 1.5T and the NOE enhancements for PCr (38±13%), Pi (25±25%), γ-ATP (11±21%), α-ATP (22±34%) were quantified. The NOE enhancement for PCr and Pi were also quantified in a primarily white matter region and primarily grey matter region for 3 subjects.

13:47 2274. Absolute Quantitation of Deoxymyoglobin Concentration in Human Hand FDI Muscle In Vivo Using NMR Signal Injection Method
Donghoon Lee 1, Catherine E. Amara 2, Kenneth I. Marro 2, Eric G. Shankland 2, Kevin E. Conley 2, Martin J. Kushmerick 2
1Paichai University, Taejon, Republic of Korea; 2University of Washington, Seattle, Washington, USA

Absolute quantitation using a synthetic signal injection method was performed to determine the dynamically changing deoxymyoglobin concentrations for human hand FDI (first dorsal interosseous) muscle in vivo. Prior to the in vivo signal acquisitions, synthetic signals were designed and calibrated on actual 1H NMR signals from phantom solutions with known deoxymyoglobin concentrations. The time course change of deoxymyoglobin concentrations for the human hand FDI muscle was then determined by the concentration references generated by the synthetic signals. Deoxymyoglobin concentration was reached to its maximum value (about 80 µM) about 6 minutes after inducing an ischemic condition to the muscle.

13:48 2275. Phosphocreatine and Neurotransmitters Changes in the Newborn Rat during Acute Hypoglycemia measured by in Vivo $^1$H NMR Spectroscopy
Ivan Tkac 1, Raghavendra Rao 1, Alexandra T. Basford 1, Michael K. Georgieff 1, Rolf Gruetter 1
1University of Minnesota, Minneapolis, Minnesota, USA

Neurochemical changes in the hippocampus of rat pups (14 days old) were measured during acute hypoglycemia using in vivo $^1$H NMR spectroscopy at 9.4 T and LCModel analysis. High spectral resolution (FWHM = 8 – 9 Hz) resulted in a neurochemical profile consisting of 14 metabolites reliably quantified from 10 µl volumes (CRLB ≤ 7%). Decreased $[\text{PCr}] / [\text{Cr}]$ ratio (plasma Glc < 2 mM) indicated energy failure. Decreased Glu was likely due to transamination to Asp providing additional energy. Brain lactate was unchanged, consistent with increased glycolysis during hypoglycemia.

13:49 2276. Increased Brain Choline Level Observed by $^1$H MRS Measurement After IV Choline Infusion
Yong Ke 1, Sue Babb 1, Mike Henry 1, Marc Kaufman 1, Perry Renshaw 1, Bruce Cohen 1
1Harvard Medical School, Belmont, Massachusetts, USA

Choline plays an important role in neuronal function. Very little choline is synthesized in brain, rather, brain choline is obtained almost entirely through the diet and transported across the blood-brain barrier by facilitated diffusion. There is some evidence that in animals and in humans, brain choline uptake is reduced with age. However, divergent results have been reported in recent years concerning changes in the 1H MRS choline resonance following choline administration to healthy human subjects. To avoid intra-subject difference in the breakdown of choline in the gastrointestinal tract, intravenous dosing was used in this study reported here.

13:50 2277. The Effects of Ketamine on Anterior Cingulate Glutamatergic Activity in Healthy Humans: A 4T $^1$H-MRS Study
Laura M. Rowland 1, Paul Mallins 1, Rex Jang 1, Rhoshel Lenroot 1, Elma Landauf 1, John Lauriello 1, Juan Bustillo 1
1University of New Mexico, Albuquerque, New Mexico, USA

Evidence suggests that glutamate dysfunction is involved in the pathophysiology of schizophrenia. NMDA antagonists, such as PCP and ketamine, induce schizophrenia-like features in healthy humans with 4T- 1H-MRS. Consistent with hypotheses, results revealed a significant increase in AC glutamine, a putative marker of glutamate neurotransmitter release, with ketamine administration. This study could potentially provide a 1H-MRS paradigm to test drugs that modulate glutamate for their potential use of treating the deteriorating course of schizophrenia.
We previously reported on the implementation of robust approaches to the detection of subcortical glutamate in human brain. This is of interest given its roles in neurotransmission and metabolism. We used a quad adiabatic refocused echo sequence to ascertain normal brain concentrations of glutamate in the hippocampus and thalamus. The nominal voxel resolution achieved with this localized spectroscopic imaging sequence is 0.51 cc. We find that glutamate concentrations in human hippocampus and temporal lobe are 4.6±0.5 mM (white) and 8.5±1.2 mM (gray). In the thalamus, glutamate is approximately 75% that of temporal gray matter, at 6.4±1.4 mM.

Purpose of our study was to prove at 3.0 T the feasibility of accurate relative and absolute quantification in small VOI centered on the hippocampus to provide normal values of the metabolite concentrations for comparison to pathological alterations in MTL diseases. We observed a 70% SNR increase in MR spectra of the hippocampus at 3.0 T which allows acquisitions in considerably smaller VOI than at 1.5 T without prolongation of measurement time. In this way, partial volume averaging over surrounding MTL tissue can be reduced at higher field strength, yielding more reliable values particularly for the hippocampal NAA concentration.

In-vivo 31P MRS was used to determine the intracellular pH (pHi) in healthy human volunteers using the chemical shift difference of Pi relative to PCR. A lower pHi was observed in the brain of adults (n=13, pHi=7.00±0.04) compared to neonates (n=12, pHi=7.09±0.05). In adults, a lower pHi was found in the cerebrum (n=14, pHi=6.95±0.05) than in the cerebellum (n=13, pHi=7.02±0.06). No sex-related differences were measured in brain tissue, but in calf muscle lower pHi levels were found for women (n=8, pH=6.97±0.02) than for men (n=9, pH=7.05±0.02). All findings are highly significant (p<0.01).

The cerebral TCA cycle rate, Vtca, was measured from a single labeling curve using either Glu C4, C3 or Asp C3, respectively, with a single TCA cycle model. The effect of assuming the transmitochondrial transport rate Vx on the measured Vtca was determined. The results indicated that the measurement of Vtca from Glu C4 critically depends on Vx, less so for Glu C3 and fitting to Asp C3 does not depend on Vx. It is proposed to use Glu C3 as a robust and sensitive indicator of Vtca.

A combination of magnetocencephalography and proton magnetic resonance spectroscopy was used to correlate the electrophysiology of rapid auditory processing and the neurochemistry of the auditory cortex in 15 healthy subjects. Our results demonstrated a significant correlation between the source strength of individual auditory responses and the concentrations of N-acetylaspartate and choline-containing compounds, regarded as neuronal and membrane markers, respectively. A significant association between the decrement of 2 consecutive N1 responses and the concentration of the glutamate/glutamine pool was also found. This investigation provides a first link between the cortical processing of auditory stimuli and the neurochemistry of the auditory cortex.

Determination of long postmortem intervals (PMI’s) is still an unsolved problem in forensic medicine. In situ brain spectra from 32 human bodies were used to calculate PMI’s based on standard curves of metabolite concentrations that have been determined earlier in a sheep model. This study shows that (a) calculated PMI’s based on brain spectra of 19 human cases with PMI’s of 11–226 h correlate reasonably well with forensic evidence, (b) forensic PMI’s are often uncertain and can rarely serve as ‘gold standard’, (c) standard curves determined in a sheep model with known PMI can be applied to human cases.
Clues for the Differentiation between Autolytic and Bacterial Products in Decomposing Brain

Michael Ith\textsuperscript{1}, Michael Thali\textsuperscript{1}, Eva Scheurer\textsuperscript{1}, Roland Kreis\textsuperscript{1}, Richard Dirnhofer\textsuperscript{1}, Chris Boesch\textsuperscript{1}
\textsuperscript{1}University & Inselspital, Berne, Switzerland

Variations of the environmental temperature pose difficult problems for the determination of postmortem intervals (PMI). Since it is expected that autolytic and bacterial breakdown products respond differently to temperature changes, a separation could be crucial for the determination of PMI. In contrast to in situ \textsuperscript{1}H-MR spectra in 32 human cases with various postmortem intervals, one exceptional case with a sterile brain tissue (unexpected at a PMI of five weeks) did not show free trimethylammonium, succinate, butyrate, isobutyrate and propionate in significant amounts, which leads to the conclusion that these metabolites are of bacterial origin in postmortem tissue.

Spectroscopic Localization and Editing Techniques

Room 554  Wednesday 13:30 - 15:30

New CSI Technique Using EPI with Tailored Pulses

Andrzej Jesmanowicz\textsuperscript{2}
\textsuperscript{2}Medical College of Wisconsin, Milwaukee, Wisconsin, USA

A new spectroscopic technique is introduced that uses chemical shift tagging instead of a Fourier Transform of the free induction signal. A time course of echo-planar images is acquired in a conventional way. Spectroscopy data are encoded in a sub-Hz range throughout the time course of the acquisition by sinusoidal tagging of the imaging region using a series of tailored RF pulses. The correlation technique is used for a spectral detection.

Proton-Echo-Planar Spectroscopic Imaging (PEPSI) in Human Brain at 1.5, 3 and 4 Tesla

Stefan Posse\textsuperscript{1}, Jeffry R. Alger\textsuperscript{2}
\textsuperscript{1}Wayne State University School of Medicine, Detroit, Michigan, USA; \textsuperscript{2}UCLA, Los Angeles, California, USA

Short TE Proton-Echo-Planar-Spectroscopic-Imaging (PEPSI) with outer volume suppression for rapid brain metabolite mapping was implemented on a new generation of 1.5, 3 and 4 Tesla scanners that share almost identical software and hardware platform. A performance comparison across field strengths showed that (a) spectral quality at short TE (32 ms) was comparable to conventional SI and (b) SNR increased approximately linearly with field strength. Typical acquisition times of metabolite maps at 4 T ranged from 4 min for 2 cc voxel size to 32 min for 0.38 cc voxel size with 64x64 matrix, with sensitivity not feasible at 1.5 T.

Short Echo Time Spiral Chemical Shift Imaging

Dong-Hyun Kim\textsuperscript{1}, Elfar Adalsteinsson\textsuperscript{1}, Daniel Spielman\textsuperscript{1}
\textsuperscript{1}Stanford University, Stanford, California, USA

Increasing the information content of magnetic resonance spectroscopy in the brain can provide valuable clinical importance. In this abstract, we have used spiral readout gradients to increase the spatial information content while short echo STEAM sequence was used to increase the spectral information content. We demonstrate that lipid contamination can be reduced while full volumetric coverage can be obtained. Also, short echo acquisition enables more metabolites to be observed.

Acquisition-Weighted Ultrashort TE Chemical Shift Imaging (aw UTE-CSI)

Matthew D. Robson\textsuperscript{1}, Peter Styles\textsuperscript{1}, Damian J. Tyler\textsuperscript{2}, Stefan Neubauer\textsuperscript{1}
\textsuperscript{1}OCMR, Oxford, UK; \textsuperscript{2}Oxford University, Oxford, UK

We describe a fundamental modification to the conventional CSI method, which enables acquisition of species with ultra-short T\textsubscript{2}. Here we minimise the delay for each k-space point individually, which yields different time delays for different fid-acquisitions in k-space. This results in an effective delay of 70µs and a time from the centre of the excitation pulse of 170µs to the centre of k-space this compares to 1-2ms for conventional methods. The benefit of this method is that there is much less decay of the signal before acquisition enabling us to image species with T\textsubscript{2} as short as 200µs.

Dynamic Whole Brain Spectroscopic Imaging using Multiple Spin Echoes at 3T

Ulrike Dyvak\textsuperscript{1}, J. Michael Tyszka\textsuperscript{1}, Dieter Meier\textsuperscript{1}, Marcello Cadoni\textsuperscript{1}, Howard Rowley\textsuperscript{5}, Timothy P.L. Roberts\textsuperscript{1}, Peter Boesiger\textsuperscript{1}
\textsuperscript{1}University and ETH Zuerich, Zuerich, Switzerland; \textsuperscript{2}Caltech, Pasadena, California, USA; \textsuperscript{3}Scientific Institute San Raffaele Hospital, Milan, Italy; \textsuperscript{4}University of Wisconsin, Madison, Wisconsin, USA; \textsuperscript{5}University of Toronto, Toronto, Ontario, Canada

Trading the increase in spectral resolution at higher field strength for acquisition speed in multi spin-echo or turbo spectroscopic imaging (TSI) allows whole brain data acquisition at 3T in approximately ten minutes. As an initial application test, TSI with an echo-train length of six was used to follow the dynamics of ethanol uptake in six slices of a normal adult volunteer. Results demonstrate regional differences in ethanol uptake fractions and thus the feasibility of dynamic whole-brain spectroscopic imaging with an 11 minute time resolution.
13:35  **2290. Comparison of SSFP Based and Classical Proton Spectroscopic Imaging Sequences**
Matthias Althaus¹, Wolfgang Dreher¹, Christian Geppert¹, Dieter Leibfritz¹
¹University of Bremen, Bremen, Germany

Various pulse sequences based on the formation of a steady state (SSFP) signal have been proposed for proton SI and demonstrated to the rat brain in vivo. In this work the signal-to-noise ratio per unit measurement time (SNR,) of the echo-like SSFP variant (spectroscopic CE-FAST) is experimentally compared to a classical spin-echo SI experiment that sets the gold standard in terms of sensitivity. Although the SNR, of the spectroscopic CE-FAST sequence is found to be lower compared to classical SI, the short minimum measurement time $T_{\text{min}}$ makes the sequence appealing to applications with high 3D spatial and temporal resolution.

13:36  **2291. Fast SSFP Based Spectroscopic Imaging Optimized For Lactate Using Partial Refocusing of Signal Modulations Caused by J-coupling**
Christian Geppert¹, Wolfgang Dreher¹, Matthias Althaus¹, Dieter Leibfritz¹
¹Universität Bremen, Bremen, Germany

Several new sequences based on the condition of steady state free precession (SSFP) have been proposed for $^3$P and $^1$H spectroscopic imaging. A modification of the spectroscopic CE-FAST sequence is described which allows very fast 3D $^1$H SI with increased sensitivity for lactate. If the chemical shift selective excitation/refocusing pulse is optimized to maximize the Lac resonance at 1.3 ppm while the coupled resonance at 4.11 is only minimally refocused, Lac at 1.3 ppm becomes nearly independent of TR. The effect is shown in phantom and in vivo/ex vivo experiments on rat brain.

13:37  **2292. Simultaneous Water and Lipid Suppression in Multi-slice Brain MR Spectroscopic Imaging**
Mai A. Smith¹, Peter B. Barker¹
¹Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

This abstract reports the inclusion of the “BOOZE” suppression technique in conjunction with reduced field of view multi-slice proton 2D MR spectroscopic imaging in vivo. The BOOZE suppression technique (Band Selective Offset-Optimized Z-Magnetization Elimination) consists of either one phase modulated hyperbolic secant, or two frequency modulated hyperbolic secant pulses, reformulated as 90° pulses and incorporated into a CHESS scheme which provide a dual stop-band for simultaneous suppression of unwanted water and lipid signals.

13:38  **2293. Lipid Suppression using Selective Inversion Recovery for 3D Spectroscopic Imaging at 3T**
Meng Gu¹, Elfar Adalsteinsson¹, Daniel Mark Spielman¹
¹Stanford University, Stanford, California, USA

Lipid suppression is essential for high-quality $^1$H chemical shift imaging (CSI) of the brain. Non-selective inversion recovery (IR) is widely used at 1.5T to allow full brain CSI coverage, however, longer T1s at higher fields are problematic. At 3T, the spectral separation between lipids and the closest metabolite is wide enough to allow a selective inversion. An inversion pulse was designed and implemented at 3T to perform selective inversion of lipids. The effect of the selective IR was tested using a spin-echo $^1$H single-slice CSI sequence. Results from an in vivo study showed significant lipid suppression and excellent metabolite spectra.

Wolfgang Dreher¹, Dieter Leibfritz¹
¹Universität Bremen, Bremen, Germany

A new two-step method for MRS without water suppression (WS) is proposed in which optimized chemical shift selective inversion of metabolite signals is applied or not applied prior to a standard PRESS sequence. The simultaneously detected water and metabolite signals can be separated by an add/subtract scheme without further modifications/adjustments of the pulse sequence or additional postprocessing techniques. The method was implemented at 4.7T, tested on phantoms and applied to rat brain in vivo. As the method is robust, easy to implement and also applicable to other localization methods, it should find broad application in MRS without WS.

13:40  **2295. Lactate Detection in Healthy Brain During Visual Stimulation Using fMRSI**
Thomas Lange¹, Ulrike Dydak¹, Peter S. Sándor¹, Peter Boesiger¹
¹University and ETH Zurich, Zurich, Switzerland; ²University Hospital Zurich, Zurich, Switzerland

In a functional SI (fMRSI) study at 3 T we investigated the time course of the lactate concentration in the visual cortex of a healthy volunteer during prolonged visual stimulation (stroboscope). The good spatial resolution (3 ml voxel size) of the 2DSI data permitted to distinguish the brain areas showing a lactate rise, which were more or less confined to the visual cortex. The lactate concentration in this area showed a significant increase after the onset of the stimulation, rose to a maximum after several minutes and fell back to the baseline level at the end of the stimulation.
Wolfgang Dreher¹, Dieter Leibfritz¹
¹Universität Bremen, Bremen, Germany

A new method for localized proton MRS is proposed which allows an increased SNR if $T_2^* \ll T_2$, thus being of particular interest at high $B_0$. After a PRESS localization module, the signal is detected both as an FID and as an echo train generated by refocusing 180° pulses. As the duration of the observed FID is incremented in a series of measurements, the echoes sample different parts along $k_\omega$, which allows to use $k$-space weighted averaging in 1D MRS for a further SNR increase. The method was implemented at 4.7 T, tested on phantoms and applied to rat brain in vivo.

13:42 2297. A Novel Approach for Reducing Chemical Shift Registration Error at 3T: Short TE CPRESS
Napapon Sailasuta¹, Ralph E. Hurd¹, Charles Cunningham¹, Daniel Vigneron¹, Sarah Nelson¹, John Pauly¹
¹GE Medical Systems, Menlo Park, California, USA; ²Stanford University, Stanford, California, USA; ³UCSF, San Francisco, California, USA

An approach for reducing chemical shift error in MRS at high field is presented. The standard PRESS sequence is modified, using two, non-linear phase, high-bandwidth, 180-degree pulses, in place of each of the traditional linear phase 180° pulses. The new short pulses match the 90-profile and bandwidth, with low peak B1 requirements. The new version of PRESS, was tested at TE 45ms on normal volunteers, and does not significantly reduce metabolite signal intensities when compared to conventional PRESS at TE 35ms. In addition to improved chemical shift registration, some strongly coupled spin systems, such as myo-inositol, are more easily quantified.

13:43 2298. Three-Dimensional Sel-MQC Mapping of Lactate and PUFAs in Human Breast Tissue at 2.1T by Hadamard Matrix Approach
Qiuhong He¹, Carol H. French-Lee², Xiangling Mao³, Bikoma C. Shungu³, Gadi Goelman⁴
¹University of Pittsburgh, Pittsburgh, Pennsylvania, USA; ²Yale University, New Haven, Connecticut, USA; ³Mount Sinai School of Medicine, New York, New York, USA; ⁴University of Pennsylvania, Philadelphia, Pennsylvania, USA

Three-dimensional MR metabolite imaging of human breast tissue with Selective Multiple-Quantum Coherence transfer (Sel-MQC) methods was accomplished on a Bruker 2.1T whole-body human MR spectrometer. The Hadamard matrix approach was applied to obtain the multi-slice MRSI images of Polyunsaturated Fatty Acids (PUFAs) and lactate in human breast tissues of healthy volunteers and in phantoms, respectively. The method retains the single-scan lipid suppression capability of the original Sel-MQC sequences.

13:44 2299. 2D iZQC: In Vivo Spectroscopy with Optimized Pulse Sequences: Water Suppression and Localization
David Balla¹, Cornelius Faber¹
¹University of Würzburg, Würzburg, Bavaria, Germany

The use of intermolecular zero-quantum coherence (iZQC) spectroscopy in vivo promises dramatic resolution enhancement in inhomogeneous tissue. We have applied new 2D iZQC pulse sequences derived from the HOMOGENIZED sequence, by alteration of the mixing pulse and combination with water suppression modules, to phantoms mimicking in vivo conditions and to the rat brain in vivo. We show that iZQC sequences can be combined with water suppression modules and that localization is possible by the use of a surface-coil.

13:45 2300. IDEAL-II: Improved IDEAL (Intermolecular Dipolar Interaction Enhanced All Lines) Method for High-Resolution MRS in Inhomogeneous Fields
Zhong Chen¹, Zhiwei Chen¹, Jianhui Zhong¹
¹University of Rochester, Rochester, New York, USA; ²Xiamen University, Xiamen, Fujian, People's Republic of China

Based on long-range dipolar interactions between the spins of solvent and solute molecules, iMQC technique was used to obtain high-resolution spectra in inhomogeneous fields via IDEAL (Intermolecular Dipolar interaction Enhanced All Lines). Here we present a modified pulse sequence, IDEAL-II, which not only greatly saves acquisition time and reduces data size, but also simplifies data post-processing. Except for a 3-fold rescaling in $J$ coupling constants, other parameters for IDEAL-II spectra in an inhomogeneous field such as chemical shifts, patterns of multiplicity, and relative areas are consistent with those extracted from one-dimensional spectra obtained in a homogeneous field.

13:46 2301. In Vivo Two-Dimensional J-Resolved GABA Spectroscopic Imaging at 4.0T
John Eric Jensen¹, Blaise deB Frederic¹, Liping Wang², John Brown², Perry F. Renshaw²
¹McLean Hospital, Belmont, Massachusetts, USA; ²GlaxoSmithKline, Uxbridge, England, UK

In vivo measurements of brain GABA were obtained using a combined 2D, J-resolved, MRSI sequence at 4.0T. Spectra were extracted from the anterior-cingulate(AC), thalamus(TH), occipital-cortex(OC) and the parietal-cortex(PC) from 7 healthy volunteers. Metabolite measurements as well as standard deviations are provided. These preliminary data suggest the feasibility of this spectroscopic imaging technique in obtaining reasonable in vivo MRSI measurements of brain GABA.
Gamma-aminobutyric acid (GABA) is an important neurotransmitter that is difficult to measure in vivo because of its low concentration (1mM), complex J-coupling, and overlapping of resonances with other metabolites. 2D J-resolved spectroscopy is one technique that may enable quantification on clinical scanners. Theoretical predictions of the expected 2D spectra are, however, not generally available for comparison with experimental and in vivo results. Here, we present numerical simulations of the 2D spectra, together with corresponding experimental results.

Localized two-dimensional spectroscopic sequences have been implemented on 1.5T and 3T Siemens scanners, equipped with multi-channel head array. An algorithm has been developed to process the multi-channel data. The result from an 8-channel head phased array coil shows improved signal to noise ratios when the best two channels are added. A new processing and quantification method has helped in more robust analysis and shorter duration of data acquisition for the same second dimension resolution.

A volume localized two-dimensional chemical exchange spectroscopic sequence (2D EXSY) has been implemented on a 1.5T MRI/MRS scanner using three slice-selective 90° rf pulses separated by TE and TM crushers. A voxel size of 27ml was chosen in the calf muscle. When TM was varied between 8ms and 1200ms, two peaks were observed: first peak between the tissue water and total creatine. b) a second peak possibly between the protons of unsaturated fatty acids. Our preliminary results show that the chemical exchange between water and creatine, and fatty acids can be non-invasively monitored in human calf muscle using 2D EXSY.

The SLIM method was employed to reconstruct the localized 1H MRS from different muscle groups in the calf. By using only about 20% of the conventional FT based CSI phase encoding steps, SLIM can generate good 1H MR spectra in bone marrow and in soleus with well resolved EMCL and IMCL peaks. The results demonstrate that the SLIM can potentially be utilized as an efficient method to quantify lipids in muscle.

An interleaved STEAM sequence was developed to acquire localised ¹H and ³¹P spectra from two arbitrarily positioned voxels in a single experiment. A new non-magnetic exercise rig with a pneumatic piston was used to demonstrate the feasibility of acquiring localised ¹H/³¹P spectra from exercising human calf muscle with a time resolution of 16s. Interleaved acquisition benefits from increased ³¹P SNR due to NOE.
13:31  **2308. Theory of Susceptibility Induced Transverse Relaxation in the Capillary Network.**

*Astrid From Frøholch1, Leif Østergaard1, Valerij G. Kiselev2*

1Århus University Hospital, Århus, Denmark; 2Freiburg University Hospital, Freiburg, Germany

An analytical model is presented for describing the transverse relaxation effect of individual paramagnetic red blood cells (RBCs) in the capillary network. Results are obtained for the free induction decay (FID), spin echo (SE) and the Carr-Purcell-Meiboom-Gill (CPMG) sequences in the diffusion-narrowing-regime. The capillaries are simulated as long arrays of spheres representing individual RBCs. The commonly used model of homogeneous cylinders is shown to underestimate by up to 55% the capillary contribution in the signal variation, which is measured in the BOLD-based fMRI. The model further represents a framework for investigating the influence of haematological effects.

13:32  **2309. Comparison between R2 and R2’ in Estimating the Iron Deposits in the Ganglia**

*Tachio Hikita1, Kazuo Abe1, Saburo Sakoda1, Hisashi Tanaka1, Kenya Murase2, Norihiko Fujita1*

1Osaka University Graduate School of Medicine, Suita, Osaka, Japan; 2Osaka University School of Allied Health Sciences, Suita, Osaka, Japan

To compare the volume of the iron deposits in brain, we examined 13 healthy volunteers by a 1.5 Tesla MRI system using two pulse sequences and compared between three transverse relaxation rates, two R2 from both the sequences and R2’ from one sequence. Both R2 have robust correlations to the iron deposits comparing to R2’. R2’ is based on gradient echo and is sensitive to macroscopic field inhomogeneity around basal ganglia. R2 is insensitive to it and retains practically enough sensitivity to the iron deposits in basal ganglia.

13:33  **2310. Clinical Implementation and Evaluation of High Resolution 3DFSE Whole Brain T1, T2 and FLAIR MR Imaging**

*Lei Zhao1, Zsuzsanna Liptak1, Nankuei Chen1, Ferenc A. Jolesz1, John P. Mugler III2, Charles RG Guttmann1*

1Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; 2University of Virginia, Charlottesville, Virginia, USA

Clinically practical single-slab 3DFSE method was successfully implemented at a clinical environment for whole brain high resolution imaging. Significant improvement of 3DFSE compared to the conventional 2DFSE approach in image quality, SNR, CNR and diagnostic value is reported. With the assistant of partial Fourier acquisition, isotropic 1x1x1 mm3 resolution T2W and 1x1x2 mm3 resolution FLAIR images could be acquired only in about 6 minutes. Single-slab 3DFSE is practical for clinical study.

13:34  **2311. Susceptibility Weighted Imaging: Why is the Negative Phase Mask So Successful in Highlighting Veins Independent of Their Orientation?**

*Yingbiao Xu1, E. Mark Haacke2*

1Wayne State University, Detroit, Michigan, USA

To better understand the phase behavior of vessels, we model a vessel as an infinite long cylinder perpendicular to main magnetic field. Our simulation results show that the phase in the image is a function of resolution, vessel size and acquisition orientation. By simulating the phase behavior, we examine the optimal resolution and acquisition orientation to maximize the contrast in the phase image and in turn to better enhance the contrast in the magnitude image. The simulated phase behavior is in good agreement with that observed from real brain datasets.

13:35  **2312. High-Resolution 3D T1 and T2 Mapping of the Brain in a Clinically Acceptable Time with DESPOT1 and DESPOT2**

*Sean CL Deoni1, Terry M. Peters1, Brian K. Rutt1*

1Robarts Research Institute, London, Ontario, Canada

The value of quantitative relaxometry for the study, diagnosis and monitoring of neurological disease has been well established. Unfortunately, the lack of a rapid, precise, high-resolution and 3D relaxometry method has hindered clinical adoption and prevented large-scale, finely-detailed investigations of T1 and T2 changes in suspected brain regions. Here we demonstrate the clinical feasibility of quantitative relaxometry with the DESPOT1 and DESPOT2 methods. We present the first 1mm isotropic resolution, full-brain matched T1 and T2 maps (acquired in 20 minutes) and the first 0.7mm isotropic resolution matched T1 and T2 maps of the deep-brain (acquired in 40 minutes).

13:36  **2313. Monte Carlo Simulation of Magnetic Nanoparticle Clustering**

*Omar Zurkiya1, Xiaoping Hu1*

1Georgia Tech/Emory University, Atlanta, Georgia, USA

Controlled clustering of magnetic nanoparticles has been exploited as a means to achieve targeted contrast. While such clustering has been experimentally demonstrated to alter relaxivity, its effect has not been systematically examined numerically. Here we present Monte Carlo simulations of the effect of clustering. Our results indicate increasing R2 with increasing number of particles involved in clustering as well as increasing binding efficiency. Although increasing binding distance causes a decrease in this effect, it remains significant at a distance as large as 1 micron. These results can be used in designing switchable magnetic nanosensors.
Phase changes in the NMR signal caused by small electrical currents have been recently proposed as a possible direct method of detecting neuronal activity. However, the smallest previously detected currents were 10 µA, three orders of magnitude too large for the detection of neuronal activity. We explored the detection of small currents using MRI microscopy at 17.6 T. The experiments show dipolar phase changes surrounding a wire immersed in gadolinium doped water. Results are reported for 3.4 µA and 970 nA current levels.

Myelin Imaging in the Brain of MS Patients via Linear Combination

Logi Vidalsson1, Kelvin Q. Lim2, Garry Gold2, John Pauly1
1Stanford University, Stanford, California, USA; 2University of Minnesota, Minneapolis, Minnesota, USA

White matter has been shown to have multieponential T2 decay. There is a short T2 component around T2 = 10 ms, which has been associated with myelin. Traditional processing involves doing least squares (LS) based curve fitting, which requires a high signal to noise ratio (SNR). In this work we used linear combination (LC) filtering to study 5 healthy volunteers and 2 patients with known MS. We found low signal intensities from the short T2 component of myelin in MS lesions visible on a FLAIR image.

Changes in T1 and T2 in Formalin Fixed Tissue Compared to Fresh Tissue at 7 Tesla

Alan Bainbridge1, Klaus Schmierer2, David H. Miller2, Roger J. Ordidge2, Tarek A. Yousry2
1University College Hospitals NHS Trust, London, UK; 2Institute of Neurology, London, UK; 2Medical Physics and Bioengineering, London, UK

High resolution MR imaging of post mortem (PM) multiple sclerosis (MS) brain offers the potential to study in detail the pathological correlates of quantitative MR changes. The aim of this study was to evaluate the changes of fundamental MR parameters (T1, T2) at 7 Tesla in PM MS brain tissue due to (i) fixation and (ii) time of fixation. T1 decreased in grey and white matter by 40% whereas T2 increased by 10-25% in grey and 30% in white matter at 60 fixation compared to fresh tissue. Tissue contrast was similar in fresh and fixed tissue.

Feasibility of Extracting Quantitative Measurements of T2 and Diffusion using Sequences Based on the Burst Concept

Simon John Doran1
1University of Surrey, Guildford, UK

The Burst sequence has previously been suggested as a candidate for quantitative measurements of T2 and diffusion coefficient. However, it gives results with low SNR. Various modulation schemes for the Burst pulse have been suggested to increase SNR, but their effect on quantitative measurements has not been verified. This work concludes that even with these schemes, the pulse angle must be restricted to small values.

Comparison Between Hahn Spin Echo and Gradient Echo Sampling of the Spin Echo (GESSE) T2 Measurements at Ultra-High Field Strength

Trong-Kha Truong1, Chastity DS Whitaker1, Petra Schmalbrock1
1The Ohio State University, Columbus, Ohio, USA

T2 measurements at ultra-high field strength (≥ 7 T) are needed for optimizing T2-weighted imaging and understanding relaxation mechanisms. However, standard methods are affected by severe radiofrequency magnetic field (B1) inhomogeneity. We implemented the Gradient Echo Sampling of the Spin Echo (GESSE) T2 measurement method at ultra-high field strength and compared it with Hahn Spin Echo T2 measurements in a phantom as well as in vivo and postmortem human brains. Our studies show the definite advantages of the GESSE method for T2 measurements at ultra-high field strength, as it is significantly faster, less sensitive to B1 inhomogeneity, and more accurate.

A Dosimetric Study of BANG Gel Calibration By T1 Relaxometry

Niall MacDougall1, Marc Eric Miquel1, Stephen F. Keevil1, Mike A. Smith1
1Guy’s and St Thomas’ Hospitals NHS Trust, London, UK; 2King’s College London, London, UK; 3University of Teesside, Middlesbrough, UK

The use of BANG gels for complex radiotherapy dosimetry is dependent on accurate calibration of T2 response versus radiation dose. This is usually achieved by irradiating small gel samples to a range of known doses to generate a calibration curve. In this work we present carefully validated T2 measurements on large and small gel-filled vials, showing that the response of T2 to dose is dependent on the size of the gel sample and that use of small samples to calibrate dose in larger phantoms may result in dosimetric errors of up to 14% in clinically relevant dose ranges.

Hexamethyldisiloxane (HMDSO), a Novel Reporter Molecule for In-Vivo Oximetry using 1H MRI

Vikram D. Kodibagkar1, Matthew E. Merritt1, Weina Cui1, Ralph P. Mason1
1UT Southwestern Medical Center at Dallas, Dallas, Texas, USA

We present here, a proof of principle for the use of hexamethyldisiloxane (HMDSO) as a novel MRI based oximetry probe. The presence of water and fat resonances is the chief hurdle in imaging and relaxometry of a proton based oximetry probe. A spin-echo EPI based imaging protocol is presented with effective water and fat suppression for potential in vivo relaxometry applications. Results of phantom studies are reported.
13:44  2321.  **Improved Multi-Exponential T$_2$ Imaging of Myelin**  
*Loyrirk Temiyakarn*, Mark D. Does  
$^1$Vanderbilt University, Nashville, Tennessee, USA

Imaging myelin content by measuring a transverse relaxation decay signal and fitting it to a T2-spectrum is hampered by the short-lived myelin signal and the relatively long first echo time required in conventional multi-echo imaging. A potential improvement to such imaging sequences stems from the consideration that the rate of irreversible transverse relaxation (R2) of myelin water likely to be larger than the rate of reversible relaxation (R2'). Thus, acquisition strategies that trade of refocusing for reduced R2 decay, such as shifting the sampling of the origin of k-space, can improve the statistics of myelin water content estimation.

13:45  2322.  **A Comparative Study of Oxygen-Sensitive Contrast Between Femoral Artery and Vein in Spin-Echo and Balanced Steady-State Free Precession Imaging**  
*Juinmiin A. Hong*, Rohan Dharmakumar*, Jean Brittain*, Graham A. Wright  
$^1$Sunnybrook & Women's College Health Sciences Centre, Toronto, Ontario, Canada; $^2$General Electric Medical Systems, Menlo Park, California, USA

Recently, we reported that the dominant source of contrast observed between oxygenated and deoxygenated blood in balanced-SSFP images can be attributed to the motion of spins through local field inhomogeneities in and around deoxygenated red blood cells. This work demonstrates that balanced-SSFP sequences can provide robust oxygen-based contrast between femoral arteries and veins, in vivo in much the same way spin-echo sequences do. In particular, we observed that the refocusing interval in spin-echo sequences is analogous to TR in balanced-SSFP and that contrast between arteries and veins may be manipulated in SSFP sequences with TR.

13:46  2323.  **Effects of T$_2$ Relaxation and Diffusion on Longitudinal Magnetization State and Signal Build for HOMOGENIZED Cross Peaks**  
*Curtis Andrew Corum*, Arthur F. Gmitro  
$^1$University of Arizona, Tucson, Arizona, USA

A analytical expression has been developed to describe the effects of T$_2$ relaxation and diffusing spatially modulated longitudinal spins during the signal build period of an HOMOGENIZED cross peak. Diffusion of the longitudinal spins results in a lengthening of the effective dipolar demagnetization time, delaying the rephasing of coupled antiphase states in the quantum picture. In the classical picture the unwinding rate of spatially twisted magnetization is no longer constant, but decays exponentially with time. The expression is experimentally verified for the HOMOGENIZED spectrum of 100mM TSP in H$_2$O at 4.7T.

**Longitudinal Relaxation and Cross-Relaxation**

Room 554  Monday 14:00 - 16:00

14:00  2324.  **In-Vivo Imaging of an Inhomogeneous Component of Magnetization Transfer in Human White Matter**  
*David Alsop*, Cedric de Bazelaire, Guillaume Duhamel  
$^1$Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

A new approach to magnetization transfer contrast is proposed that employs subtraction of three images with different off-resonance irradiation to produce an image of the inhomogeneous component of the bound pool. This approach is evaluated in-vivo in the human brain and is demonstrated to produce images, which highlight white matter, especially those areas with higher myelin water fraction.

14:01  2325.  **On the Design of PARACEST Agents for Clinical Applications: SAR Considerations**  
*Ileana Hancu*, Thomas W. Dixon, Robert E. Lenkinski, A Dean Sherry, Donald E. Woessner  
$^1$GE GRC, Niskayuna, New York, USA; $^2$Harvard Medical School, Boston, Massachusetts, USA; $^3$University of Texas Southwestern Medical Center, Dallas, Texas, USA

Paramagnetic CEST agents have emerged as a new class of MRI contrast agents. For this novel concept to reach the clinic, one must ensure that the agent design allows for the contrast to be obtained through RF irradiation compliant with FDA SAR guidelines. We present a model that links the contrast obtained with CEST agents to their physical characteristics and to the saturating RF field. There is an optimum proton exchange lifetime that maximizes contrast while observing SAR guidelines. This optimum lifetime depends on the clinical application, coil size and type, and field strength.

14:02  2326.  **Magnetization Transfer of 5-FU in Model Systems**  
*Scott D. Swanson*  
$^1$University of Michigan, Ann Arbor, Michigan, USA

Measurement of the concentration of drugs and drug metabolites is important for product development and dose determination. NMR is able to monitor delivery, clearance, and metabolism of 5-fluorouracil (5-FU) in vivo with 19-F spectroscopy. The sensitivity of 19-F spectroscopy is relatively low and limits temporal and spatial resolution. We present here a method to increase the sensitivity of detecting 5-FU in model systems by more than an order of magnitude by saturating the pyrimidine proton resonance of 5-FU and measuring changes in the water proton magnetization.
Quantitative magnetization transfer (qMT) allows measurement of parameters reflecting local chemical and biophysical properties of brain tissue. Alzheimer's disease (AD) is associated with neuronal loss, gliosis and accumulation of extracellular amyloid plaques and intracellular neurofibrillary tangles in brain tissue. This pilot study measured 4 qMT parameters in the hippocampal formation (HF) in 7 AD patients and 7 controls. AD patients had significantly (p<0.002) lower 1/RAT2A in the HF and this correlated (r=0.76) with mini-mental state examination in patients. No differences were found in gMoA, fb/RA(1-fb) and T2B parameters. Further investigation of qMT parameters in a larger sample is planned.

14:04 2328. On the Effect of Oral Corticosteroids on Magnetization Transfer Imaging (MTI) Measurements

Stefan C.A. Steens1, Faiza Admiraal-Behloul1, Ad C.G.M. van Es1, Gerda M. Steup-Beekman1, Gerlof P.Th. Bosma1, Hans Olofsen1, Tom W.J. Huizinga1, Mark A. van Buchem1

1Leiden University Medical Center, Leiden, Netherlands

Magnetization transfer imaging (MTI) has proven a valuable tool to detect and quantify lesion load in diffuse white matter diseases. Aim of this study was to assess the influence of oral corticosteroid (CS) medication on MTI measurements. MTI was performed in healthy subjects and rheumatoid arthritis patients with and without CS, all without cerebral disease. After correcting for age, no significant differences were found for MTI measurements. Our results suggest that in patients with cerebral disease that are on CS medication, MTI abnormalities can be attributed to the underlying disease and are not confounded by CS effects.

14:05 2329. Assessment of Dynamic Averaging From Transverse Relaxation in the Rotating Frame (T2ρ) During Anadibatic HSN Pulses.

Shalom Michaeli1, Dennis J. Sorce1, Djouadat Idiyatullin1, Heidi Grohn2, Olli Grohn2, Risto Kauppinen2, Kamil Ugurbil1, Michael Garwood1

1University of Minnesota, Minneapolis, Minnesota, USA; 2A.I. Virtanen Institute for Molecular Sciences, Kuopio, Finland; 3University of Manchester, Manchester, UK

Time-dependent transverse relaxation in the tilted double rotating frame (T2ρ(t)) during an adiabatic spin-echo sequence (CP-LASER) was investigated. An explicit derivation of T2ρ(t) for adiabatic pulses (HSn family; n=1 or 4) was derived. Apparent transverse relaxation times T2ρ of water in glycerol were measured with different HSn and HS4 pulses. A significant difference of the T2ρ measured with HS1 vs HS4 pulses was observed for water in glycerol and for brain Creatine/Phosphocreatine (3.03 ppm). T2ρ measurements performed with different HSn pulses have differential sensitivity to dynamic averaging.

14:06 2330. Comparison of the Myelin Related Proton Pool and the MTR

Stefan Ropele1, Christian Enzinger1, Siegrid Strasser-Fuchs1, Franz Fazekas1

1University of Graz, Graz, Austria

It is commonly believed that the macromolecular or fractional pool size (FPS) in brain tissue represents myelin content. The magnetization transfer ratio (MTR) is often used as a measure for demyelination and structural tissue changes. We now have measured the FPS in lesions and normal appearing regions in brain tissue of multiple sclerosis (MS) patients and have compared these findings with conventional MTR measurements. Our results suggest that the MTR in brain tissue mainly reflects myelin but may be affected also by other factors.

14:07 2331. Assessment of Dynamic Averaging From Transverse Relaxation in the Rotating Frame (T2ρ) During Adiabatic HSn Pulses.

Shalom Michaeli1, Dennis J. Sorce1, Djouadat Idiyatullin1, Heidi Grohn2, Olli Grohn2, Risto Kauppinen2, Kamil Ugurbil1, Michael Garwood1

1University of Minnesota, Minneapolis, Minnesota, USA; 2A.I. Virtanen Institute for Molecular Sciences, Kuopio, Finland; 3University of Manchester, Manchester, UK

Time-dependent transverse relaxation in the tilted double rotating frame (T2ρ(t)) during an adiabatic spin-echo sequence (CP-LASER) was investigated. An explicit derivation of T2ρ(t) for adiabatic pulses (HSn family; n=1 or 4) was derived. Apparent transverse relaxation times T2ρ of water in glycerol were measured with different HSn and HS4 pulses. A significant difference of the T2ρ measured with HS1 vs HS4 pulses was observed for water in glycerol and for brain Creatine/Phosphocreatine (3.03 ppm). T2ρ measurements performed with different HSn pulses have differential sensitivity to dynamic averaging.

14:08 2332. Three-Dimensional Quantitative Magnetisation Transfer Imaging of the Human Brain

Mara Cercignani1, Mark R. Symms1, Philip A. Bouly1, Daniel J. Tozer1, Paul S. Tofts1, Gareth J. Barker2

1Institute of Neurology, London, UK; 2Institute of Psychiatry, London, UK

This work investigates the advantages of a 3D SPGR acquisition for quantitative MT over 2D acquisition, in terms of SNR, and also analysing the variability of the fitted parameters with the degree of T1-weighting. Thanks to the increased SNR, maps of the bound proton fraction, f, with relatively high resolution can be obtained.
Off-resonance irradiation as an alternative means for generating contrast with superparamagnetic particles is investigated in this work. Experimental data demonstrate that an off-resonance effect, distinct from the MT effect, exists, and it depends on off-resonance frequency and MION concentration and can be potentially used as an alternative contrast mechanism. Our data suggest a useful offset range of 500Hz-1500Hz for particles of 5nm average diameter. MION with concentrations as low as 20 micromolar were readily identifiable in ratio images. A detailed investigation of this contrast mechanism will fully establish its utility.

The response of R₁, R₂, R₁ρ, and MTC of MAGIC polymer gel dosimeters at several magnetic field strengths is reported. Discussion on the advantages and disadvantages of MTC and its use in MAGIC polymer gel dosimetry is included.

Two readily observed effects in solution magnetic resonance (MR) – radiation damping and the dipolar field – combine to generate chaotic spin dynamics in routine experiments. The extreme sensitivity of the chaotic spin dynamics to experimental conditions, the butterfly effect, suggests a novel means to amplify small variations in MR parameters. In this work, we develop a periodic radio-frequency (RF) control scheme that is shown to heighten the butterfly effect. Incorporating the butterfly effect and chaos control in imaging experiments on a simple phantom enhances the sensitivity and contrast in chemical exchange-dependent saturation transfer (CEST) difference imaging by 10-fold.

We investigate the influence of the apparent translational diffusion (ADC) coefficient of water on the efficiency of magnetization transfer processes between water molecules and the exchangeable hydrogens of biomolecules. We obtained z-spectra (360.13 MHz, 22°C) from 1M solutions of oxidized glutathion in water at pH 4.0, pH 7.0 and pH 9.0 in the absence and presence of 50% glycerol. Glycerol addition decreased water ADC from 1.5 to 0.3 cm² s⁻¹ modifying significantly the z-spectra obtained at the three pH´s. In general, decreased ADC’s increased the efficiency of MT processes, this effect being pH dependent and more important ca. pH 7.0.

The 3D FLASH sequence is frequently used in structural imaging of the brain. Depending on the imaging parameters, this sequence can generate contrast between gray and white matter derived from differences in proton density and T₁. In this study an assessment was made of the contrast-to-noise ratio (CNR) between gray and white matter at 3T achievable within a constant imaging time.

In cases where tissue water content changes or a contrast agent is used, the associated T₁ changes can be small. For short TR gradient echo imaging, we show that the appropriate choice of flip angle to optimize signal change is sqrt(3)*(the Ernst angle). Further, when a contrast agent is used, it is possible to quantify the amount of contrast agent required to create a visible effect for either a single tissue or for tissue containing blood.
14:15  2339. **Elongated $T_1$ Values in Human Brain and the Optimization of MDEFT Measurements at 4.7T**

Nobuhiro Takaya¹, Hidehiro Watanabe¹, Fumiyuki Mitumori¹
¹National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan

$T_1$ values for the grey and white matters of 1.63 and 1.07s, respectively in human brain at 4.7T were significantly increased compared with those values at 4T. We made an optimization of the MDEFT measurements based on the increased $T_1$. Both the theoretical calculation and the actual measurements on the phantom which simulated $T_1$ and $T_2$ at 4.7T indicated the best CN ratio between the grey and white matters with the $T_M$ around 2.8s. In the actual measurement in the human brain with $T_M$ of 2.0s, the CN ratio was improved approximately 40% compared with the measurement optimized at 4T.

14:16  2340. **Gd-DTPA Relaxivity in Rat Nervous Tissue**

Timothy M. Shepherd¹, Stephen J. Blackband¹, Greg J. Stanisz²
¹University of Florida, Gainesville, Florida, USA; ²Sunnybrook/University of Toronto, North York, Ontario, Canada

Gadolinium contrast is frequently used clinically for angiography and for the diagnosis of mass lesions. Further, recent studies have used the extracellular water relaxation properties of gadolinium chelates to estimate transmembrane exchange rates and the intracellular fractions of nervous tissue. Several previous reports have suggested that the relaxivity of gadolinium can vary with tissue environment. We measured gadolinium relaxivity in viable cortical brain slices and found significant differences for nervous tissue compared to the relaxivity of aqueous solutions. Studies should determine the changes in relaxivity in nervous tissue so that data is properly interpreted.

14:17  2341. **Probing Dimensions of Periodic Microstructures Using Intermolecular Multiple-Quantum Coherences at 1.5 T**

Stefan Kirsch¹, Peter Bachert¹
¹German Cancer Research Center (DKFZ), Heidelberg, Germany

In liquid $^1$H NMR, the distant dipolar field generated by the bulk of the protons enables intermolecular multiple–quantum coherences (iMQCs). Recently, it has been shown that these signals contain information about the dimension of samples with periodic structure. In this study, two phantoms with different periodic structures were explored on a 1.5–T whole–body scanner. Different orders $n$ of iMQCs were generated using a phase–cycled CRAZED–type pulse sequence. We demonstrate that for $n=2$ and 3 information on the characteristic length scale &lambda of the structure can be obtained.

14:18  2342. **$^1$H Single and Double Quantum MRI Evaluation of Tendon Regeneration Mediated by Engineered Stem Cells**

Keren Keinan-Adamsky¹, Hadassah Shinar¹, Gadi Pelled², Yoram Zilberman², Dan Gazit², Gil Navon¹
¹Tel Aviv University, Tel Aviv, Israel; ²Hebrew University-Hadassah Medical Center, Jerusalem, Israel

$^1$H single and double quantum filtered MRI is a sensitive method for depicting order in biological tissues. We have used this method to follow regeneration of injured rat Achilles tendons (AT), in which a collagen sponge containing adult mesenchymal stem cells combined with potent inducers of tenocyctic differentiation factor was implanted. Our results show regeneration of the collagen fibers, a month after implantation while no regeneration was observed for the same time after implantation of a sponge without the cells. This is the first report of healing of an AT injury by engineered stem cells.

Other MRI Sequences
**13:32 2345. 3D Radial FID-Sampling for Ultrashort TE Imaging at 3 T**

Jürgen Rahmer¹, Peter Börnert², Christoph Schröder², Christian Stehning²

¹Philips Research Laboratories, Hamburg, Germany; ²University of Karlsruhe, Karlsruhe, Germany

A 3D radial free-induction-decay (FID) sampling scheme is used to achieve ultrashort echo-times (UTE), which are necessary to image fast-relaxing spin species typically found in highly ordered tissue. The 3D acquisition allows isotropic spatial resolution and avoids several difficulties which arise in standard 2D UTE sequences. In-vivo measurements of feet and knees demonstrate that 3D data acquired at 3 T furthermore provides a high signal-to-noise ratio (SNR) and facilitates the examination of short-T2 components in complex joint structures.

**13:33 2346. MRI Scan Time Reduction with Combo Acquisitions: First Images Acquired on a Clinical Scanner**

Ralf Mekle¹, Ed Xuekui Wu², Stephan G. Wetzel³, Klaus Scheffler¹

¹University of Basel, Basel, Switzerland; ²Columbia University, New York, New York, USA; ³University of Basel/University Hospital, Basel, Switzerland

The first MR images acquired with the combo acquisition approach to reduce clinical MRI scan time and improve data utilization are presented. The approach combines the acquisition of images of different contrasts into a single scan, using variable acquisition parameters and k-space data sharing. In this work, spin echo (SE) combo acquisition protocols have been successfully implemented on a clinical MRI scanner. Data was acquired in phantom studies and for human volunteer and patient cases. Results were compared with images from corresponding standard acquisitions. No major artifacts were observed with combo scans at scan time reductions of up to 52%.

**13:34 2347. Cerebral Temperature Mapping by Self-Referenced Proton Spectroscopic Imaging Thermometry**

J.S. Thornton¹, E.B. Cady², A. Bambridge³, A.N. Priest¹, O. Iwata⁴, S. Iwata⁴, S. Shannagalingam⁵, N. Robertson⁶, J.S. Wyatt⁶, R.J. Ordidge⁶

¹National Hospital for Neurology and Neurosurgery, London, UK; ²University College London and UCLH NHS Trust, London, UK

Non-invasive temperature mapping in newborn piglets was achieved using non-water-suppressed proton spectroscopic imaging. This method exploited the temperature-dependent chemical shift difference between water protons and the temperature-stable methyl resonance of n-acetylaspartate. Regional patterns of cerebral temperature reduction produced by both whole body hypothermia and selective head cooling were demonstrated. This modelled the application of therapeutic hypothermia in newborn infants exposed to perinatal hypoxia-ischaemia. The technique is clinically applicable for the measurement of cerebral temperature distributions in human subjects.

**13:35 2348. Quiet MR Sequences for Routine Head Examinations: A Volunteer Study**

Thorsten Alexander Bley¹, Claudia Oesterle¹, Markus Uhl², Oliver Spec elevate, Juergen Hennig¹, Mathias Langer¹

¹University of Freiburg, Freiburg, Baden-Württemberg, Germany

This study presents an evaluation of image quality of quiet sequences designed to decrease distressing acoustic MR scanner noise. Quiet T1-weighted spin echo and T2-weighted turbo spin echo sequences have been programmed using long sinusoidally shaped gradient ramps with a corresponding inflow saturation module. Head scans of 12 volunteers were evaluated concerning loudness and image quality. The acoustic noise reduction was between 23 and 32 dB. This corresponds to a subjective decrease of around 95%. Equally good diagnostic quality was found. Drastic reductions of noise levels with maintained high image quality are feasible without any hardware modification.

**13:36 2349. Single Point Imaging with Suppressed Sound Pressure Levels Through Gradient-Shape Adjustment**

Peter Latta¹, Marco L.H. Gruwel¹, Earle Edie¹, Milos Sramek¹, Boguslaw Tomanek¹

¹NRC, Winnipeg, Manitoba, Canada; ²OAW - Visualisierung, Vienna, Austria

Acoustic noise produced by gradient coils using SPI was investigated. Gradients parameters for both linear and sine-shaped gradient ramps were modified to minimize the noise levels. SPI with the optimized gradient waveform was found to be a superb alternative to the SPRITE method which inevitably suffers overheating of the gradient coils.

**13:37 2350. Non-Linear Magnetic Field Application for MR Imaging: Traveling Pulse Encoding**

Jose Miguel Fernandez¹, Pablo Irarrazaval¹

¹Universidad Catolica de Chile, Santiago, Chile

We propose a technique to encode MR images using non-uniform, non-stationary magnetic fields. These fields, moving along the encoding direction, result in the convolution of the image with the phase introduced by the magnetic field directly in the space domain. Thus, the recovery of the image requires de-convolving the acquired signal. The shift from frequency to spatial domain encoding allows changing the acquisition paradigm with the purpose of obtaining images sampled at a higher rate instead of at a higher gradient.
**An Investigation of the Accuracy of 3D T$_2^*$ Mapping of Ultra-Fast Relaxing Species with Conical-SPRITE**

Sandro Romanzetti$^1$, Meghan Halse$^2$, Joachim Kaffanke$^1$, Bruce J. Balcom$^2$, N. Jon Shah$^1$

$^1$Research Centre Juelich, Juelich, Germany; $^2$University of New Brunswick MRI Centre, Fredericton, New Brunswick, Canada

The accuracy of 3D T$_2^*$ mapping of ultra-fast relaxing (T$_2^*$ $\sim$ 1 ms) species with Conical-SPRITE has been investigated. We have obtained a bulk T$_2^*$ value of 1.12 ms for a heavily doped water phantom. A highly homogeneous T$_2^*$ map with a representative T$_2^*$ of 1.11 ms was obtained of the same phantom by fitting a series of T$_2^*$ weighted images to a mono-exponential, demonstrating excellent agreement with the bulk value. Our results indicate that bi-exponential fitting of data from $^{23}$Na, for example, resulting in quantitative T$_2^*$ maps of the fast- and slow-relaxing components should be feasible.

**Effects of Subpixel Integration on PERL Signal Simulations**

Mirko I. Hrovat$^1$, Samuel Patz$^2$

$^1$Mirtech, Inc., Brockton, Massachusetts, USA; $^2$Brigham and Womens Hospital, Boston, Massachusetts, USA

Numerical simulations of MRI signals generated by the PERL imaging sequence are presented. The PERL field encodes two dimensions simultaneously by employing a product of a PERiodic and a Linear spatial encoding field. The simulations provide a useful tool to test imaging sequences and the reconstruction procedures. One aspect of the simulations reveals severe aliasing of echoes unless the appropriate integration (analytic or numerical) is performed over subpixels.

**K-Space Information Map**

Jose Ignacio Bilbao$^1$, Jose Luis Ulloa$^1$, Marcelo Guarini$^1$, Pablo Irarrazaval$^1$

$^1$Universidad Católica de Chile, Santiago, Chile

Available under-sampled trajectories assume that information in k-space is concentrated in the lower frequencies. In this work we use an entropy approach to quantify k-space information distribution for one slice of the head. We calculate each frequency component entropy from a set of 500 images. The obtained distribution of k-space entropy has a Gaussian like shape, except for the lower frequencies where there is a peak of entropy. The results validate the common assumption of k-space information distribution, and constitute a useful tool for trajectory design.

**Magnetic Resonance Electrical Impedance Tomography (MREIT) with a 3.0 Tesla MRI System**

Suk Hoon Oh$^1$, Byung Il Lee$^1$, Soo Yeol Lee$^1$, Eung Je Woo$^1$, Tae Seok Park$^1$, Min Hyoung Cho$^1$

$^1$Kyung Hee University, Yongin, Kyungki, Republic of Korea

We present experimental results of Magnetic Resonance Electrical Impedance Tomography (MREIT) performed without any subject rotations on a 3.0 Tesla MRI system. MREIT is a newly introduced conductivity imaging modality which combines MRI and electrical impedance tomography (EIT). With a specially designed conductivity phantom, we have evaluated the performances of MREIT including noise characteristics and spatial resolution. We have found that the spatial resolution reaches 2mm and the L2 error in the reconstructed conductivity image ranges in 18-38% when the injection current is 12mA. In vivo animal imaging with smaller currents will be done in future studies.

**Magnetic Resonance Current Density Imaging Without Subject Rotations**

Suk Hoon Oh$^1$, Won Hee Lee$^1$, Soo Yeol Lee$^1$, Min Hyoung Cho$^1$

$^1$Kyung Hee University, Yongin, Kyungki, Republic of Korea

Magnetic resonance current density imaging (MRCDI) is a useful tool to measure electrical current density inside a subject. Due to the requirement of subject rotations in conventional MRCDI, MRCDI has not been widely applied to in-vivo studies. In this work we propose a new current density imaging method by which a single component of the current density can be imaged without any subject rotations. We reconstruct the current density images in the spatial frequency domain using a spatial filter. Experimental results of a phantom study with a 3.0 Tesla MRI system are presented.
BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)
MR Spectroscopy Applications: In Vivo Dynamic Metabolism and Metabolomics

Room B-1  Monday 14:00 - 16:00  Chairs: J.D. Glickson and D.L. Rothman

14:00  2358. MR Angiography and MR Spectroscopy of Deoxymyoglobin for Efficacy Assessment of Gene Therapy in Critical Limb Ischemia
Roland Kreis1, Harriet C. Thoeny, Oliver Kummer, Christian Roelfke, Corinna Skjelsvik, Chris Boesch1
Iris Baumgartner
1University & Inselspital, Berne, Switzerland

The ability of magnetic resonance angiography (MRA) and spectroscopy (1H MRS) of deoxymyoglobin to assess collateralization and tissue perfusion in limb ischemia in patients undergoing VEGF-C gene therapy (n=4), balloon angioplasty (n=4), exercise training (n=2) or no therapy (n=2) was evaluated. Reproducibility was tested in 2 independent examinations. MRA demonstrated different sized collaterals, with good perception of changes. 1H MRS had good reproducibility at determining tissue perfusion, and was able to quantify changes in correspondence to clinical course and pressure measurements. MRA and 1H MRS provided complementary information, and may help to assess the efficacy of therapeutic angiogenesis.

14:10  2359. The ATP Flux Generated by Creatine Kinase in the Human Heart at Rest and during Stress
Paul A. Bottomley1, Gary Gerstenblith2, Robert G. Weiss2
1Johns Hopkins University, Baltimore, USA; 2Johns Hopkins University, Baltimore, Maryland, USA

Although the creatine kinase (CK) reaction plays a central role in cardiac energy supply, direct measures of the ATP flux supplied by CK have not been possible in the beating human heart. We have now quantified energy flux through CK in the human heart using 31P MRS with the Four Angle Saturation Transfer (FAST) method in combination with water-referenced metabolite concentration measurements in a single exam. We report that myocardial ATP synthesis through CK is less than that in skeletal muscle, and that cardiac CK flux in normal humans is largely unchanged by a pharmacologically-induced doubling of cardiac workload.

14:20  2360. Impaired Creatine Kinase ATP Supply in the Failing Human Heart
Paul A. Bottomley1, Gary Gerstenblith2, Robert G. Weiss2
1Johns Hopkins University, Baltimore, USA; 2Johns Hopkins University, Baltimore, Maryland, USA

Because chemical energy fuels myocardial contractile function, inadequate myofibrillar supply of high-energy phosphate could underly contractile dysfunction in human heart failure. The creatine kinase (CK) reaction is a vital source of ATP. 31P MRS reveals modest reductions in CK metabolite levels in patients with moderate to severe heart failure, but CK levels do not directly index the ATP flux supplied by CK. We have quantified ATP production via CK in the failing human heart using in vivo 31P MRS. We report that the ATP synthesis rate and flux through CK are reduced by 40% to 50%, which may be limiting.

14:30  2361. Changes of Cerebral Phosphate Metabolism in Human Primary Visual Cortex during Functional Activation Observed by In Vivo 31P MRS at 7T
Hao Lei1, Xiao-Hong Zhai, Ying-Xia Li2, Kamil Ugurbil1, Wei Chen1
1University of Minnesota, Minneapolis, Minnesota, USA; 2State Key Laboratory of Magnetic Resonance and Molecular and Atomic Physics, Wuhan, People's Republic of China

Three dimensional 31P chemical shift imaging was performed on human primary visual cortex at 7T during control and visual stimulation. The activated areas were determined by gradient-echo based MRI, and localized 31P spectra from the activated areas were selected and analyzed. The results show that, in the activated areas, the phosphocreatine concentration had a slight but statistically significant decrease, and the phosphocholine concentration had a significant increase (25%). The Pi and ATP concentrations as well as intracellular pH did not change significantly during functional activation. This work demonstrates that high-field 31P MRS is useful for studying bioenergetics regarding brain activation.

14:40  2362. Inorganic Phosphate is not Limiting in Glycogenolytic Initiation
Alex Hsu1, Babacar Cisse2, Louise Lee3, M Joan Dawson3
1University of California San Diego, San Diego, USA; 2Columbia University, New York, New York, USA; 3University of Illinois Urbana-Champaign, Urbana, Illinois, USA

Since Pi is a substrate for glycogen degradation, it has been suggested that Pi availability limits glycogenolysis in anaerobic skeletal muscles. This is supported by 31P MRS experiments, demonstrating a transient alkalization only when [Pi] is low. This transient alkalization indicates little/no glycogenolysis. 31P MRS was performed on anaerobic skeletal muscle undergoing 1 Hz twitch trains separated by periods of rest. A transient alkalization is observed at the start of each twitch train, irrespective of Pi concentration. It is demonstrated that initiation of glycogenolysis is independent of Pi concentration, which argues against a limiting role for Pi.
Brain intracellular pH (pHi) has profound effects on cellular processes and cell viability. The aim of this study was to assess brain pHi changes and pHi heterogeneity using high field 31P MRS before, during and after an acute HI cerebral insult in an experimental model of the developing brain. High field 31P MRS demonstrated two main pHi compartments in normoxic brain and in the subacute phase following HI corresponding to pHi values of around 7.3 and 7.0. The amplitude of the more alkaline component was approximately double the amplitude of the more acidic component at 42-48 hours.

The tricarboxylic acid (TCA) cycle plays a central role in energy production in the heart. In addition, it also provides biosynthetic intermediates for many anabolic pathways. The existence of the malic enzyme pathway has been well established in many tissues, including heart. There has also been indirect evidence of malic enzyme activity, with the direction of the net flux dependent upon intracellular redox state and/or substrate concentrations. Significant activity of this pathway could confound analysis of 13C-NMR spectra. In this report, we provide direct evidence for significant activity of this pathway in isolated perfused rabbit hearts.

The brain contains a significant amount of glycogen, whose precise role in maintaining brain function is still unclear. Recent studies reported glycogen supercompensation in rat brain following hypoglycemia and suggested that brain glycogen maybe involved in the hypoglycemia unawareness syndrome in patients with diabetes. Using localized 13C NMR spectroscopy at 9.4 Tesla, brain glycogen C1 was measured in rat brain after hypoglycemia. The study reports brain glycogen resynthesis after a single hypoglycemic episode and occurs in a close to linear manner for more than 14 hours.

Enhanced cardiac glucose utilization was visualized by PET in mice prior characterized by MRI to be functionally and morphologically normal. The metabolic switch was confirmed by 13C NMR isotope studies of isolated hearts. Proteome analysis demonstrated that key enzymes of mitochondrial lipid oxidation were downregulated in myo-/- hearts while the glycolytic enzyme GAPDH was upregulated. The data show that myoglobin aside of its role in tissue oxygen delivery plays a key role in muscle substrate selection.

The objective of this study was to evaluate whether anaplerotic flux changes in response to intense neuronal activation. We used 13C NMR spectroscopy together with an infusion of [2-13C]glucose to assess anaplerosis under baseline conditions (1% halothane anesthesia) and during bicuculline-induced seizures. We found that the turnover of Glu-13C3 from [2-13C]glucose, which reflects the anaplerotic pathway, was similar between baseline and seizures despite the large increase in neurotransmitter cycling flux. The results indicate that anaplerotic flux did not increase with increasing cortical activity.

The TCA cycle flux (VTCA) and the regional cerebral metabolic rate of glucose (rCMRglc) were measured in monkeys under identical experimental conditions by 1H NMR spectroscopy using 13C-labeled glucose and 18FDG-PET (fluoro-deoxy-glucose) positron emission tomography (PET), respectively. Comparison of the two datasets were in good agreement with the literature values (VTCA = 0.55±0.04 µmol.g\(^{-1}\).min\(^{-1}\), n=4; rCMRglc = 0.24±0.01 µmol.g\(^{-1}\).min\(^{-1}\), n=2) and the [rCMRglc/VtCA] ratio was 0.44 consistent with the near 1:2 stoichiometry between glycolytic and oxidative metabolism. To our knowledge, this work is the first direct comparison of NMR spectroscopy using 13C-labeled glucose and 18FDG-PET.
Chronic Hypoglycemia Increases the Brain Glucose Concentration: A $^{13}$C NMR Study

Hongxia Lei$^1$, Tianwen Yue$^1$, Dee M. Koski$^1$, Kelly S. Reck$^1$, Jeannette Zinggeler$^1$, Rolf Gruetter$^1$

$^1$University of Minnesota, Minneapolis, Minnesota, USA; $^2$Penn State University, University Park, Pennsylvania, USA

Glucose is the major source of energy for brain function. Recent studies have reported that glycogen can be supplemented by brain glycogen during acute hypoglycemia. However, during chronic hypoglycemia, glucose transport in the brain has been implicated. The present study shows that chronic hypoglycemia results in elevated brain glucose concentrations in the rats, which is consistent with reported increasing glucose transport and glucose transporter protein expression at the blood brain barrier.

Novel Acquisition Approaches in Cancer

Room B-2  Monday 14:00 - 16:00  Chairs: J.L. Evelhoch and C.S. Springer

MR Imaged Characteristics of Tumor Angiogenesis Depends on Molecular Size of Contrast Agents

Quido G. de Lussanet$^1$, Sander Langereis$^2$, Regina G.H. Beets-Tan$^1$, Arjan W. Griffioen$^1$, Marcel H.P. van Genderen$^2$, Walter H. Backes$^1$

$^1$Maastricht University Hospital, Maastricht, Netherlands; $^2$Eindhoven University of Technology, Eindhoven, Netherlands

To evaluate the effect of molecular size of contrast agents on MR imaging derived markers for tumor angiogenesis (endothelial transfer coefficient and plasma fraction), dendrimer contrast agents with different molecular sizes were used for dynamic contrast-enhanced MR imaging in a mouse tumor model. Our results show that plasma fraction values are grossly overestimated with small molecular (< 3 kDa) contrast agents. Endothelial transfer coefficient values reflect sole microvessel permeability when using larger molecules (>12 kDa), but reflect a combination of permeability and heterogeneous microcirculatory flow when using smaller molecules, of which both are characteristic properties of tumor angiogenesis.

Quantitative Perfusion Measurements of Liver Metastasis from DCE-MRI using Inversion Recovery TrueFISP

Ralph Strecker$^1$, Klaus Scheffler$^2$, Jürgen Hennig$^1$

$^1$University Hospital, Freiburg, Baden-Württemberg, Germany; $^2$University Hospital, Basel, Switzerland

A new technique is represented for quantitative dynamic contrast-enhanced MRI (DCE-MRI) of liver metastasis. It is based on the repeated acquisition of a 2D slice using an Inversion Recovery trueFISP sequence with multiple readouts enabling an accurate T1 quantitation. Pharmacokinetic parameters (Ktrans, Ve) as well as iAUC values are obtained by custom-built analysis software with semiautomatic tracking of the metastasis.

A Dynamic Contrast Enhanced MRI Protocol Optimised to the Concentration Ranges of P792 Detected in the Vascular Input Function and Tumour

Daniel P. Bradley$^1$, Hideto Kuribayashi$^2$, David R. Checkley$^1$, Steve R. Wedge$^1$, Jean JT Tessier$^1$

$^1$AstraZeneca, Macclesfield, UK

A modified keyhole sequence (0.5s/image) was optimised for the acquisition of the vascular input function (VIF) and tumour P792 kinetics in a xenograft model. P792 (‘Vistarem’, Guerbet, Paris) is a gadolinium chelated macro-molecular (6.47 kDa) rapid clearance blood pool agent (RCBPA) currently in Phase III trials. P792 concentration changes observed in the tumour and VIF differ by orders of magnitude. Consequently, by combining a small flip angle and a spatially selective saturation band across the ventricle we were able to accurately resolve concentration changes in these two compartments subsequently fitting the data to resolve tumoural haemodynamic parameters.

Monitoring Chemotherapy Induced Changes in the Carcinogen ENU Induced Infiltrating Ductal Adenocarcinoma and Non-Infiltrating Papillary Adenocarcinoma by Longitudinal MRI studies

Min-Ying Su$^1$, Mark J. Hamamura$^1$, Huali Wang$^1$, Hon J. Yu$^1$, Jun Wang$^1$, Philip M. Carpenter$^1$, Orhan Nalcioglu$^1$

$^1$University of California, Irvine, California, USA

The wide variation of tumor types and grades induced by ENU were used to simulate human breast tumors. Their response to chemotherapy (Taxotere) was studied. Longitudinal MRI was applied to measure tumor volume and contrast enhancement kinetics of Gd-DTPA-BMA and Gadomer-17. Infiltrating ductal adenocarcinomas showed mixed response, fibroadenomas did not respond well, and all 3 non-infiltrating papillary adenocarcinoma were stabilizers. The baseline Gadomer-17 enhancements at 1-min and 2-min revealed a significant difference between +/− tumor growth groups at week-1, suggesting that tumors with a higher vascularity measured by Gadomer-17 had a better response, possibly due to more drug delivery.
14:40 2374. **Differences in Lymphatic Drain Following VEGF Overexpression in a Human Breast Cancer Model**

Arvind P. Pathak1, Dmitri Artemov1, Venu Raman1, David G. Jackson2, Michal Neeman3, Zaver M. Bhujwalla4

1Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; 2John Radcliffe Hospital, Oxford, UK; 3Weizmann Institute of Science, Rehovot, Israel

Several studies have investigated the effects of VEGF-C and -D on lymphangiogenesis, but few have focused on effects of full-length VEGF-A on the lymphatic continuum. This is the first in vivo functional MRI study to noninvasively characterize differences in lymphatic/convective drainage between MCF-7 breast cancer xenografts overexpressing full-length VEGF, and vector transfected control tumors. We detected significantly enhanced lymphatico-convective drainage at tumor-tissue interfaces for VEGF overexpressing MCF-7 tumors compared to control MCF-7 tumors. Consistent with these observations, fluorescence microscopy of the novel lymphatic endothelium marker (LYVE-1) detected a trend of dilated lymphatic vessels in peritumoral regions of VEGF overexpressing tumors.

14:50 2375. **Thioredoxin Inhibition Endpoints for PX-478, a Novel Cancer Therapeutic, by Pre-Clinical Dynamic Contrast Enhanced MRI and 1H MRS**

Matt Runquist1, Sarah Swaim1, Dominique Jennings1, Natarajan Raghu1nd, Garth Powis1, Robert J. Gillies1

1University of Arizona, Tucson, Arizona, USA

Magnetic resonance imaging (MRI) has the capability to provide early tumor response data in anti-angiogenic therapy. We have employed dynamic contrast enhanced MRI (DCE-MRI) with both small (Magnevist®) and large (albumin-Gd-DTPA) MW contrast reagents to monitor response of HT-29 colon cancer xenografts to PX-478 in mice. Initial results indicate that treatment with 125 mg/kg PX-478 causes an acute reduction in iAUC of Magnevist 2-4 hours following treatment. We also observed a decrease in the albumin-Gd-DTPA enhancement by 4 hours following drug treatment. Changes in the total choline resonance with PX-478 treatment were visible by in vivo 1H MRS.

15:00 2376. **Contrast Enhanced Tumor MRI with a Biodegradable Macromolecular Gd(III) Complex in Mice**

Yuda Zong1, Xinghe Wang1, Craig Goodrich2, Dennis Parker2, Zheng-Rong Lu1

1University of Utah, Salt Lake City, Utah, USA; 2LDS Hospital, Salt Lake City, Utah, USA

Biodegradable macromolecular Gd complex, Gd-DTPA cystine ethyl ester, was investigated for tumor MR imaging in nude mice bearing MB 231 breast cancer xenographs. The agent produced significantly more contrast enhancement in the blood pool and tumor tissue than a control agent, Gd-(DTPA-BMA). Strong contrast enhancement was observed at 5 minutes postinjection and signal intensity then gradually decreased. Significant contrast enhancement was still visible at 1 hour postinjection.

15:10 2377. **Micro-Magnetic Resonance Mammo-Lymphangiography using a Nano-size Contrast Agent to Image Lymphatic Drainage of the Breast Cancer in Mice**

Hisataka Kobayashi1, Satomi Kawamoto1, Yoshio Sakai1, Peter L. Choyke1, Martin W. Brechbiel1, John C. Morris1, Thomas A. Waldmann1

1National Institutes of Health, Bethesda, Maryland, USA; 2Johns Hopkins University, Baltimore, Maryland, USA

There is a need for precise identification of sentinel lymph nodes in patients with breast cancer. Improvements to current imaging methods using MRI with a newly synthesized nano-size, paramagnetic particle are an attractive goal. A four dimensional method of micro-MR mammo-lymphangiography using a nano-size, paramagnetic contrast agent (G6; 9nm/ 240 kDa) is developed to visualize the lymphatics and lymph nodes draining mouse breast cancers. The conventional MR contrast agent, Gd-DTPA-dimeglumine (<1 kDa), failed to depict the lymphatics. MR mammo-lymphangiography using nano-size paramagnetic contrast agents is far more powerful in the localization of sentinel nodes in breast cancer than conventional methods.

15:20 2378. **Effect of Reduced Encoding Dynamic Data Size on Permeability-Surface Area Estimation**

Michael Aref1, Josh D. Handbury1, Jim Xiquan J1, Keith L. Bailey1, Zhi-Pei Liang, Erik C. Wiener1

1University of Illinois at Urbana-Champaign (UIUC), Urbana, Illinois, USA; 2The Chicago Medical School, Chicago, Illinois, USA; 3Texas A & M University, College Station, Texas, USA; 4University of Pittsburgh Cancer Institute, Pittsburgh, Pennsylvania, USA

We test the hypothesis that dynamic reference sets in reduced-encoding techniques have spatial resolution limits for accurate quantitative tumor typing based on volume normalized contrast agent transfer rates between tumor plasma and extravascular extracellular space, Kp,v, obtained from dynamic contrast enhanced MRI. Specifically, we compared Kp,v/VT “hot spot” values of ten infiltrating ductal carcinomas, obtained with fully reconstructed FFT to those obtained from Keyhole, reduced-encoding imaging by generalized-series reconstruction (RIGR), and two-reference RIGR (TRIGR), using dynamic data of decreasing size. Preliminary data suggests that TRIGR has lower resolution limits on dynamic data for obtaining accurate Kp,v/VT than Keyhole or RIGR.
15:30  **2379. Clinical Utility of a Novel Whole-Body MRI System for Comprehensive Oncologic Staging**

Heinz-Peter Wilhelm Schlemmer¹, Christina Pfannenberg¹, Marius Horger¹, Katrin Wolfarth¹, Katrin Tomaschko¹, Holger Hebart¹, Michael Fenchel¹, Stefan Miller¹, Claus D. Claussen¹  
¹University Hospital Tuebingen, Tuebingen, Germany; ²Siemens Medical Solutions, Erlangen, Germany

Whole-body MR imaging for oncologic staging using conventional MR scanners is considerably limited in clinical routine because multiple repositioning of patients significantly prolong the examination time. Goal of this study was to evaluate the clinical utility of a novel 1.5T whole-body MR scanner designed for complete head-to-toe coverage (MAGNETOM Avanto, Siemens, Erlangen, Germany). Results were compared to combined findings in conventional MRI, CT and skeletal scintigraphy. Within a total scan time of 50 min the comprehensive whole-body MRI protocol could correctly visualize tumor spread to distant organs including bone. Whole-body oncologic staging with MRI is feasible and may be cost-effective.

15:40  **2380. Multistation Coronal Whole Body-MRI Imaging on 3 T. First results of a Feasibility Study.**

Nadir Alexander Ghanem¹, Oliver Speck¹, Ute Ludwig¹, Jürgen Hennig¹, Mathias Langer¹  
¹University Hospital Freiburg, Freiburg, Germany

A new clinical protocol for coronal multistation Whole Body-MRI on 3 Tesla MRI unit using a TurboSTIR-sequence was developed. The imaging findings were compared to the established imaging findings of FDG-PET, Whole Body-MRI, skeletal scintigraphy, CT, and MRI of the different body regions. Ten cancer patients and ten volunteers underwent both Whole Body-MRI imaging techniques. The preliminary results of our study demonstrate that Whole Body-MRI as a fast and accurate examination in cancer patients is nearly feasible in 6 min and the findings are comparable to a multistation coronary Whole Body-MRI on a 1.5 Tesla MRI unit.

15:50  **2381. MR Imaging with a Continuously Rolling Table Platform and High-Precision Position Feedback**

Michael O. Zenge¹, Harald H. Quick¹, Florian M. Vogt¹, Mark E. Ladd¹  
¹University Hospital Essen, Essen, Germany

Emerging MR imaging techniques like 3D MR angiographic peripheral runoff studies up to whole-body MRA, whole-body MRI screening as well as interventional MRA studies require imaging beyond the constraints of a conventional field-of-view. The AngioSURF rolling table platform permits such whole-body MRI with surface-coil image quality based on a multistation imaging approach. Here, a method is presented in which extended longitudinal field-of-view 2D and 3D data sets are acquired in one seamless image. The proposed method continuously acquires data during manual table movement. A MR-scanner triggered laser sensor provides the precise table position. First continuously acquired whole-body images are presented.

**BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)**

**Design Considerations for RF Coils in Parallel Imaging**

Sakura  Tuesday 13:30 - 15:30  Chairs: M.B. Smith and J.V. Hajnal

13:30  **2382. Diagonal-Arranged Quadrature Coil Arrays for 3D SENSE Imaging**

Pei H. Chan¹, Keith Michael¹, Bob Anderson¹  
¹USA Instruments, Inc., Aurora, Ohio, USA

A key requirement for the design of a parallel imaging array is that the local complex sensitivity profiles of the coil elements need to be distinctive enough from each other. In this paper, we present an 8-element quadrature array coil with each of its eight elements being diagonally arranged to optimize the distinctiveness of the complex sensitivity generated by the coil elements. The diagonal-arranged quadrature (DAQD) coil provides 3D SENSE imaging capability not only for an 8-channel MRI system but also for a 4-channel MRI system if the eight elements are properly combined into four output channels.

13:40  **2383. Concentric Coil Array with Multidimensional Symmetry for Parallel MRI of the Heart**

Michael Abram Ohliger¹, Charles McKenzie², Robert Greenman³, Graham Wiggins², Randy Giaquinto⁴, Daniel Sodickson²  
¹Harvard-MIT Division of Health Sciences and Technology, Boston, Massachusetts, USA; ²Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; ³Massachusetts General Hospital, Boston, Massachusetts, USA; ⁴GE Global Reseach Center, Niskayuna, New York, USA

Arrays used for parallel MRI generally consist of elements aligned in a single preferred direction. Such arrays perform poorly when reconstructing data in planes that are oblique to the main axis of the array. Concentric coil arrays, which consist of elements placed concentrically on top of one another, are able to provide spatial information in multiple directions at once. We describe a 4-element concentric coil array optimized for cardiac imaging. In initial applications, the array provides high quality reconstructions and excellent coverage for both fully gradient-encoded and parallel imaging in a variety of image planes.
13:50 2384. An 8-Channel Body Array Coil for Abdominal Parallel Imaging at 3.0T

Hiroyuki Fujita1, Steve Zhang1, Michael Donofrio1, Ken Schanz2, Tsinghua Zheng2, Jacob Weaver1, Kolman Juhasz1, Julia Klinge1
1USA Instruments, Inc., Aurora, Ohio, USA; 2GE Medical Systems, Milwaukee, Wisconsin, USA

We present a parallel-imaging (PI) compatible 3.0T 8-channel body array coil for abdominal imaging. At 1.5T, it has been reported that the clinical acceptability of parallel-acquisition depends upon how well they tolerate loss of SNR. In fact, image quality for some applications at 1.5T suffers or is unacceptable from a clinical-evaluation standpoint when PI techniques are applied due to the inevitable loss of SNR that results from reducing Ts. The intrinsic increase of SNR assured by 3.0T together with the PI optimized coil enables achieving clinically superior image quality even when PI techniques are applied.

14:00 2385. A 21-Channel High Performance Combo Head-Neck-Spine-Cardiac Coil for 3D Parallel Imaging Applications

Pei H. Chan1, Tara Scott1, Kevin Phelan1, Bob Anderson1, Labros Petropoulos1
1USA Instruments, Inc., Aurora, Ohio, USA

The quest for MRI systems with larger number of receiving arrays allows the design of a multi-functional RF coils to distribute sufficient channels/coil elements at each region of interest (ROI) and provide performance that can meet or exceed that of a dedicated regional RF coil. In this paper we present a 21-channel combo head-neck-spine-cardiac coil that has been proven to be able to provide higher SNR and better coverage than does an 8-channel brain coil, an 8-channel Cervical-Thoracic-Lumber (CTL) coil, and an 8-channel cardiac coil for head, neck/c-spine, and aortic arch imaging.

14:10 2386. A Novel 15-Element SENSE-Compatible Vertical Field PV Array Coil

Sunyu Su1, Fraser Robb1, Yiping Guan1, Shuren Zhao1
1USA Instruments - GEMS, Aurora, Ohio, USA

Clinical imaging of peripheral vasculature (PV) on a horizontal MRI system is quite limited by patient size. Vertical field PV array has the advantage of accommodating larger patients for PV studies. The challenge is that the array coil must cover a very large volume and provides high sensitivity and resolution for clinical PV studies. Existing array configurations fail to meet such requirement. In this work, we have applied solenoidal array concept to design a 15-element multi-station vertical field open PV coil that provides excellent SNR, uniform coverage of peripheral vasculature and allows for SENSE imaging in S/I and A/P directions.

14:20 2387. 32-Channel Head Coil Array for Highly Accelerated Parallel Imaging Applications

Harvey E. Cline1, Daniel K. Sodikson2, Thoralf Niendorf3, Randy Giaquinto1
1General Electric, Niskayuna, New York, USA; 2Harvard Medical School, Boston, Massachusetts, USA; 3General Electric, Waukesha, Wisconsin, USA

A 32-channel head coil array was designed for parallel imaging applications. Elements resemble a dog bone with a wider region at each loop end serving to null the adjacent loop mutual inductance while allowing inter-element gaps at the narrower loop centers. The measured circuit characteristics of the fabricated coil conformed to the design parameters. Coil performance was examined in phantom and volunteer studies. Anatomical T1 and T2 weighted imaging of the brain was performed with high spatial resolution and contrast-to-noise ratio using bi-dimensional acceleration with total acceleration factors as large as 9.

14:30 2388. Parallel Imaging Performance for Densely Spaced Coils in Phase Arrays at Ultra High Field Strength

Steen Moeller1, Pierre-Francois Van de Moortele1, Gregor Adriany1, Carl J. Snyder1, Peter M. Andersen1, John P. Strupp1, J Thomas Vaughan1, Kamil Ugurbil1
1University of Minnesota, Minneapolis, Minnesota, USA

The objective of this study was to experimentally examine parallel imaging performance as a function of increasing number of individual coils in the human head at 7 Tesla using parallel arrays with 4, 8, 16 and a 32 elements, with the specific goals of evaluating i) impact of coil design on reduction factors, ii) the maximal reduction factors that can be practically attained for human head imaging at 7 T and iii) the convergence of the reduction factors towards a theoretical maximum.

14:40 2389. The Linear EIGENCOIL®

Uli Gotshal1, Randy Duensing1, Charlie A. Saylor1, James Akao1, Feng Huang1, Alan Holland1, David A. Molyneaux1
1MRI Devices Corp., Gainesville, Florida, USA

The concept of eigenmodes for a linear phased array is presented, and the requirements for the eigen-combiner are analyzed. The elements of a linear phased array are connected to such a combiner, to form the linear EIGENCOIL® that generates the eigenmodes of the coil system. The eigenmodes are shown as phantom images obtained by reconstruction of the eigen-combiner output channels. The combined image (sum-of-squares of the eigenmodes) is compared to the conventional sum-of-squares reconstruction of the array elements. In addition, and based on orthogonality properties of the eigenmodes, a channel-reduction scheme, which preserves SNR at the target area, is shown.
**A Novel Head/Neck Coil Design Using Matrix Clusters And Mode Combiners**

Arne Reykowski\textsuperscript{1}, Martin Hemmerlein\textsuperscript{1}, Steffen Wolf\textsuperscript{1}

\textsuperscript{1}Siemens Medical Solutions, Erlangen, Germany

A novel approach to parallel imaging arrays for the head and neck region is presented. The so called head and neck “Matrix Coils” consist of several clusters of linear polarized (LP) elements which are combined via “Mode Matrix” combiners to form an equal number of mode signals which allow a scalable use of receiver channels as a function of acceleration factor and/or peripheral SNR.

**8 Channel Double Spiral Head Array Coil for Enhanced 3D Parallel MRI at 1.5T**

Matthias Mueller\textsuperscript{1}, Felix Breuer\textsuperscript{1}, Martin Blaimer\textsuperscript{1}, Robin Heidemann\textsuperscript{1}, Andrew Webb\textsuperscript{1}, Mark Griswold\textsuperscript{1}, Peter Jakob\textsuperscript{1}

\textsuperscript{1}University of Wuerzburg, Wuerzburg, Germany

In the last years large receiver banks providing up to 64 channels have been developed. Recent studies have suggested that a spiral like array configuration may be beneficial for massively parallel volume imaging. Since this design provides good spatial encoding in all directions, high reduction factors could be achieved with 3D parallel imaging techniques. The goal of this work is to build a prototype 8 channel spiral phased array coil to investigate problems in construction and encoding performance in axial direction of this coil design.

**Superconducting 200 MHz "Phased" Array for Parallel Imaging**

Jaroslaw Wosiak\textsuperscript{1}, Krzysztof Nesteruk\textsuperscript{2}, Lei-Ming Xie\textsuperscript{1}, Maged Kamel\textsuperscript{1}, Lian Xue\textsuperscript{1}, James A. Bankson\textsuperscript{1}

\textsuperscript{1}University of Houston, Houston, Texas, USA; \textsuperscript{2}Polish Academy of Sciences, Warsaw, Poland; \textsuperscript{3}The University of Texas M.D. Anderson Cancer Center, Houston, Texas, USA

In recent years, the design of phased arrays for parallel acquisition has become the subject of a great deal of research. As the number of array elements increases and their size continues to decrease, coil losses become more dominant in the system. SNR can therefore be increased significantly by the use of cryogenically cooled copper and/or HTS coils. We report on the design, fabrication and MRI test in 4.7 Tesla Bruker scanner, of a novel planar superconducting (multi-layered YBa2CuO3/CeO2/Au) array, which was designed, fabricated and integrated with a cryostat according to requirements of array designing rules and cryogenics.

**An Investigation into the Role of Dielectric Resonance in Parallel Imaging**

Florian Wiesinger\textsuperscript{1}, Pierre-Francois Van de Moortele\textsuperscript{2}, Gregor Adriany\textsuperscript{2}, Nicola De Zanche\textsuperscript{1}, Carl Snyder\textsuperscript{2}, Tommy Vaughan\textsuperscript{2}, Kamil Ugurbil\textsuperscript{2}, Klaus Paul Pruessmann\textsuperscript{1}

\textsuperscript{1}ETH and University Zurich, Zurich, Switzerland; \textsuperscript{2}University of Minnesota, Minneapolis, Minnesota, USA

In order to address concerns about the impact of dielectric resonance on parallel imaging performance, sensitivity encoding (SENSE) experiments were conducted in the presence of resonant modes. Experiments were performed with two different phantom geometries on a 7 Tesla system and different amounts of salinity. The results suggest that degeneracy of dielectric modes favors parallel imaging. In the general non-degenerate case, parallel imaging performance was reduced at zero salinity yet improved to common values at in-vivo conductivity. Most importantly, these results indicate that dielectric resonance may not be a major obstacle to in-vivo parallel imaging at ultra-high fields.

**T\textsubscript{2} of Articular Cartilage in the Presence of Gd-DTPA(2-)**

Miika T. Nieminen\textsuperscript{1}, Nina Menezes\textsuperscript{1}, Ashley Williams\textsuperscript{1}, Deborah Burstein\textsuperscript{1}

\textsuperscript{1}Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

T\textsubscript{2} and dGEMRIC are currently measured in separate studies since the inherent T\textsubscript{2} may be affected by Gd-DTPA(2-). In the current study, T\textsubscript{2} was measured in cartilage at 8.45T. T\textsubscript{2}-weighted images showed similar image contrast with and without Gd-DTPA(2-). Quantitative T\textsubscript{2} maps demonstrated that Gd-DTPA(2-) provides a non-negligible mechanism for relaxation with higher (1mM) Gd-DTPA(2-) equilibrating concentrations; these maps showed loss of conspicuity of T\textsubscript{2} abnormalities, but the inherent T\textsubscript{2} was successfully back-calculated by estimating Gd-DTPA(2-) concentration from dGEMRIC and assuming a T\textsubscript{2} relaxivity. A clinical data set demonstrated no effect of Gd-DTPA(2-) on T\textsubscript{2} maps with double-dose Magnevist.

**The Biexponential Nature of T\textsubscript{2} Decay in Articular Cartilage**

Hadasassh Shimar\textsuperscript{1}, Keren Keinam-Adamsky\textsuperscript{1}, Gil Navon\textsuperscript{1}

\textsuperscript{1}Tel Aviv University, Tel Aviv, Israel

The transverse relaxation time of the water protons in articular cartilage, T\textsubscript{2}, reflects the macromolecular organization. We have shown that the intensity decay curve is best described by a biexponential function, with the fast relaxation times ranging from 1 ms near the bone to 8 ms in the radial zone. The two exponentials were correlated with the two quadrupolar splittings observed by \textsuperscript{1}H DQF spectroscopic imaging. T\textsubscript{2} decay curves in articular cartilage fitted to a single exponential depend heavily on the choice of echo times and thus must be used with caution.
13:50 2396. **Transverse Relaxation Mechanisms in Articular Cartilage**

Vladimir Mlynárik¹, Pavol Szomolányi², Renato Toffanin³, Franco Vittur³, Florian Gruber³, Siegfried Trautig³

¹University of Vienna Medical School, Vienna, Austria; ²Slovak Academy of Sciences, Bratislava, Slovakia; ³PROTOS Research Institute, Trieste, Italy; ⁴University of Trieste, Trieste, Italy; ⁵Orthopedic Hospital Gershofen, Vienna, Austria

Relaxation rates in the rotating frame ($R_\text{ip}$) and spin-spin relaxation rates ($R_\text{s}$) were measured in articular cartilage. It was found that $R_\text{ip}$ in the radial zone depended on the orientation of specimens in the magnet and decreased with increasing spin locking field strength. The $R_\text{ip}$ values in the transitional zone were nearly independent of orientation and the spin locking field. The experiments reveal that the dominant $T_\text{ip}$ and $T_\text{s}$ relaxation mechanism at lower fields is dipolar. The contribution of scalar relaxation due to proton exchange is negligible.

14:00 2397. **Glucosamine Modulated Changes in Articular Cartilage Detected by $T_1$ Imaging**

Sarma V. S. Akella¹, Matthew Corbo¹, George R. Dodge², Andrew J. Wheaton³, Ravinder R. Regatte¹, Ravinder Reddy¹

¹University of Pennsylvania, Philadelphia, Pennsylvania, USA; ²Alfred I. duPont Hospital for Children, Wilmington, Delaware, USA

The purpose of this study is to investigate whether $T_1$ imaging detects the changes in articular cartilage as a result of glucosamine in the experimentally induced degradation of cartilage using bovine articular cartilage explants. Measured $T_1$ and proteoglycan content of cartilage following treatment with glucosamine show that the proteoglycan loss induced by the interleukin 1β is replenished by glucosamine. This demonstrates that $T_1$ imaging can detect small changes in cartilage proteoglycan content and that glucosamine can modify the IL-1β induced changes. This work suggests that the $T_1$ technique has an application in monitoring cartilage for the effectiveness of therapeutic interventions.

14:10 2398. **Dynamic MR Elastography of Cartilage Degradation**

Orlando Lopez¹, Kimberly K. Amrami¹, Phillip Rossman¹, Richard L. Ehman¹

¹Mayo Clinic, Rochester, Minnesota, USA

The aim of this work was to develop a laboratory tool based on Magnetic Resonance Elastography (MRE) technology to overcome limitations of in vitro methods in direct and noninvasive quantification of the dynamic mechanical properties of articular cartilage. MRE of bovine articular cartilage plug samples of 1 cm in diameter was performed using control and enzyme digested samples. Estimates of shear stiffness were indicative of decreased stiffness according to enzyme degradation of the cartilage. This work demonstrates the use of MRE in the study of articular cartilage mechanics as well as its sensitivity to detect minor structural changes.

14:20 2399. **Multi-Parametric MRI Assessment of Cartilage Repair with Correlation to Histology**

Mikko Nieminen¹, Carl S. Winalski², Jarno Rieppo¹, Mikko Lammi¹, Stanislav Lechpanner³, Kara Johnson¹, Tom Minas², Ilkka Kiviranta²

¹Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; ²Brigham and Women's Hospital, Boston, Massachusetts, USA; ³University of Kuopio, Kuopio, Finland

The ability of MRI techniques to characterize macromolecular composition and structure of cartilage repair was investigated. Osteochondral samples from minipigs operated with osteochondral defects and osteochondral autograft transfer were assessed with various MRI parameters ($T_2$, $T_1$, dGEMRIC and D) and histology (safranin-O-staining, H&E-staining, immunostaining for type II collagen and polarized light microscopy). Histology of osteochondral defects revealed low-GAG, non-hyaline-like, fibrous repair tissue, with concurrent low dGEMRIC and $T_2$ values. MRI parameters and histology showed normal cartilage appearance of the osteochondral transfer. The interface between transfer and residential cartilage was visible by qualitative MRI images and revealed poor integration by histology.

14:30 2400. **Proton Magnetic Resonance Spectroscopy (1H-MRS) of Tibialis Anterior Muscle: Intra-Individual Variation of Metabolite Ratios in Healthy Volunteers**

Martin Torriani¹, Bijoy J. Thomas², Megan E. Jensen³, Elkan F. Halpern⁴, William E. Palmer⁴, Daniel I. Rosenthal⁴

¹Massachusetts General Hospital, Boston, Massachusetts, USA

The objective of this study was to determine the short-term intra-individual variation of tibialis anterior metabolite ratios in healthy volunteers measured by 1H-MRS at 1.5T and 3.0T. We utilized PRESS 3000/25-30 ms and measured ratios of intramyocellular lipids (IMCL) and total creatine (TCr) relative to unsuppressed water. Our results indicate same-day IMCL coefficients of variation (CV) of 9-11% (1.5T) and 9% (3.0T). Repeat scans performed 12 days later show CVs of 17-18% (1.5T) and 19-20% (3.0T). Same-day CVs of TCr were 5% at 1.5T and 3.0T; repeat scans showed CVs of 3% (1.5T) and 5% (3.0T).

14:40 2401. **Measurement of Resting Perfusion and Perfusion Anisotropy in Muscle with Velocity Selective ASL**

Lawrence R. Frank¹, Eric C. Wong¹

¹UC San Diego, La Jolla, California, USA

The measurement of perfusion in muscle using the spatial tagging schemes of standard ASL is complicated by the long transit delays and complex vascular geometry feeding local muscle groups. Velocity selective ASL (VS-ASL) provides an alternative that is insensitive to transit delays. Moreover, it has the additional feature that it can be sensitized to perfusion direction, thereby facilitating perfusion measurements along different encoding axes, from which can be derived measures of anisotropy. Using VS-ASL, we demonstrate resting perfusion and perfusion anisotropy in the calf muscles of a normal human volunteer.
14:50 **2402.** MR Phase Contrast Study of Differences in Structure-Function Relationship during Isometric and Passive Movement of Lower Leg.

Shantanu Sinha¹, Taija Finni¹, John Hodgson¹, Alex Lai¹, Reggie Edgerton¹
¹University of California at Los Angeles, Los Angeles, California, USA

The complex multipennate architecture of the triceps surae muscle-tendon complex was first elucidated with high resolution 3D MRI and subsequently correlated with changes in functionality during isometric and passive movement. Peak shortening velocity (functionality) was determined by gated, phase contrast imaging. During isometric and passive plantarflexion tasks the distribution of muscle velocity and movement was not uniform, with distinct areas relatively stationary while others showed large movements. In isometric contractions the fastest moving tissues were in close proximity of the aponeurosis structure that was connected to the Achilles tendon whereas the slowest movements occurred close to the aponeurosis of origin.

15:00 **2403.** Can Larger Intramyocellular Lipid (IMCL) Content Conserve Glycogen During Endurance Activity and Increase Maximal Performance?

Michael Ith¹, Monica Zehnder², Emanuel R. Christ³, Kevin Acheson⁴, Roland Kreis¹, Jacques Décombaz², Chris Boesch¹
¹University & Inselspital, Berne, Switzerland; ²Nestlé Research Center, Lausanne, Switzerland

The relative contributions of intra-myocellular lipids (IMCL) and glycogen to the energy demands during exercise are still a matter of debate. This study investigates the effect of different IMCL levels on IMCL and glycogen utilization during sub-maximal exercise in 11 trained subjects, and shows that higher IMCL levels increase IMCL utilization. Since increased IMCL depletion does not influence glycolysis, it is concluded that the consumption of plasma energy substrates is reduced when higher IMCL levels are available. Higher dietary lipid content tends to increase maximal performance without reaching significance.

15:10 **2404.** Correlation between Intra-myocellular Lipids and a Structural Parameter in Human Calf Muscles by ¹H MRSI

Peter Vermathen¹, Roland Kreis¹, Chris Boesch¹
¹University & Inselspital, Berne, Switzerland

Previous studies have shown higher IMCL content in slower compared to faster muscle fibers. However, the large IMCL differences between muscles cannot be explained by fiber type alone. This ¹H-MRSI study aimed at correlating IMCL levels in different calf muscles with muscle fiber orientation. Thirty measurements in ten subjects were performed. IMCL and fiber orientation were significantly different between some of the investigated muscles. Furthermore, a significant correlation between fiber orientation and IMCL content was found. This suggests that both, IMCL levels and fiber orientation, may be related to different muscle tasks, which require different force and velocity.

15:20 **2405.** Role of Central Adiposity on IMCL Accumulation and Glucose Intolerance in a Mouse Model of Insulin Resistance

Marion Korach-Andre¹, Michael Beil¹, Richard Deacon¹, Jiaping Gao¹, Didier Laurent¹
¹Novartis Pharmaceuticals Corp., East Hanover, New Jersey, USA

This study examined whether visceral fat as measured by MRI can act as a modulating factor of intramyocellular lipids (IMCL) as measured by localized ¹H-MRS at 9.4T in a mouse model of insulin resistance. The diabetogenic treatment with dexamethasone resulted in an increase of IMCL in the tibialis anterior (TA) by 47% while visceral fat contents were also found 77% greater than in saline-treated mice. These results support the hypothesis that an enlarged visceral fat mass contributes to the development of insulin resistance through an increase in IMCL.

**BASIC SCIENCE FOCUS SESSION (WITH E-POSTERS)**
Parallel Imaging: Reconstruction Methods and Regularization


13:30 **2406.** Relative SENSE (rSENSE) and Sensitivity Map Calculation from k-Space Reconstruction Coefficients (SMACKER)

Peter Ullmann¹, Quang Tieng², Graham Galloway³, Juergen Hennig¹
¹Freiburg University Hospital, Freiburg, Germany; ²University of Queensland, Brisbane, Australia

This study demonstrates the possibility of calculating sensitivity maps of array coil elements relative to one particular reference element from generalized weighting coefficients. These coefficients are derived from the theory of SMASH, in which they are used to reconstruct missing k-space data. If relative sensitivity maps are used in a SENSE algorithm, referred to as rSENSE (relative SENSE), the reconstructed image corresponds to a fully sampled image taken by the reference array element. To get a combined image the rSENSE algorithm is repeated with each element as reference and the resulting images are combined by, for example, a sum-of-squares.
13:40 2407. **Inpainting for Sensitivity Maps**

Feng Huang, Yunmei Chen, Charles Saylor, Andrew Rubin, James Akao, Randy Duensing

1MRI Devices Corporation, Gainesville, Florida, USA; 2University of Florida, Gainesville, Florida, USA

Inpainting is an image interpolation method. PDE based digital inpainting techniques have been finding broad application. In this work, PDE based inpainting techniques are applied to the field of MR parallel imaging. A novel inpainting model is initially introduced. This model is then applied to correct sensitivity maps. Coil sensitivity maps are important in parallel imaging and they often need extrapolation and hole filling. These problems can be solved simultaneously by applying inpainting techniques. Experiments for determining coil sensitivity maps for different MR images demonstrate the speed and accuracy of the proposed new model.

13:50 2408. **Estimation of Coil Sensitivity Profile in k-space for Parallel Imaging**

JianMin Wang

1Siemens Mindit Magnetic Resonance Ltd, Shen Zhen, People's Republic of China

A good estimation of the local coil profile is essential to reduce the wrap around artifacts in parallel acquisition technique. In this paper, a novel method has been presented, which uses k-space fitting to estimate the coil sensitivity profiles. Compared to the conventional low-resolution image method, the new method calculates the coil profiles directly in k-space and is less sensitive to the signal variations in image domain. Therefore this method is suitable for estimation of local coil profiles with parallel acquisition technique.

14:00 2409. **Improved Preconditioning for the Non-Cartesian SENSE Reconstruction with Regularization**

Holger Eggers, Peter Boesiger

1Philips Research Laboratories, Hamburg, Germany; 2University and ETH Zurich, Zurich, Switzerland

Regularization has proven to be beneficial to the reconstruction of sensitivity-encoded acquisitions. Applied to non-Cartesian SENSE imaging, it permits to stabilize the iterative procedure for solving the underlying inverse problem, but at the same time it affects the convergence behavior and thus the running time of the reconstruction. In this work, the preconditioning usually employed to accelerate the convergence is shown to become less effective in conjunction with a regularization. A modification to it, which involves an adaptation to the selected regularization, is proposed and demonstrated to preserve the speed of convergence achieved without regularization to date.

14:10 2410. **Backus-Gilbert Regularization for SENSE Imaging**


1Case Western Reserve University, Cleveland, Ohio, USA; 2Philips Medical System, Cleveland, Ohio, USA

A new regularization technique for SENSE image reconstruction is considered. This technique, Backus-Gilbert regularization, constrains both the expected deviation of the reconstructed image from the true image and the stability of the image. This regularization requires no prior knowledge of the likelihood of the image which is crucial for the application of linear regularization. Our reconstruction applied to simulated data acquired with a four-element phased array coils and reduction factor (R=4), and sensitivity maps calculated by Biot-Savart, show that there is a reasonable trade-off between signal and aliasing for a given weighting factor.


Ashish Raj, Ramin Zabih, Yi Wang

1Cornell University, Freeville, New York, USA; 2Cornell-Weill Medical College, New York, USA; 3University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

Traditional parallel imaging methods using SENSE are non-optimal in the presence of sensitivity noise. We present an optimal SENSE algorithm for this case using a total least squares formulation. An efficient and fast iterative algorithm is presented to solve the TLS problem without recourse to expensive SVD computations required by general TLS. Results indicate almost 15 dB improvement in SNR in some cases compared to standard SENSE.

14:30 2412. **Sensitivity Encoded Image Reconstruction Using Direct Regularization**

Fa-Hsuan Lin, Fu-Nien Wang, Teng-Yi Huang, Matti S. Hamalainen, Kenneth K. Kwong, John W. Belliveau, Lawrence L. Wald

1Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, Massachusetts, USA

A direct automatic regularization technique is introduced in this study to achieve fast estimation of regularization parameter in SENSE unfolding. The SNR of the linear equation relating the observed aliased image from multiple RF coils and unknown spin density is calculated and then utilized to estimate the regularization parameter. Results of the reconstructed images and g-factor maps based on this direct regularization technique are similar to those using L-curve regularization. The computational time for regularization parameter is reduced to 54%, 33% and 29% of the time used by the L-curve technique in 2.00-, 2.67- and 4.00-fold accelerations.
**14:40 2413. Artifact and Noise Suppression in High Resolution GRAPPA Imaging**

*Jae seok Park*, *Quang Zhang*, *Orlando Simonetti*, *Deliao Li*

1Northwestern University, Chicago, Illinois, USA; 2Siemens Medical Solutions, Chicago, Illinois, USA

High-resolution images reconstructed by GRAPPA suffer from residual aliasing artifacts and noise amplification when a least squares fitting for the coil calibration is applied to highly fluctuating data in signal intensity along the phase encoding direction. In this work, to reduce the signal variation of the calibration data, a modified reconstruction algorithm is introduced excluding the high signal lines in the central region of k-space in the least squares fitting. Variable density sampling trajectories in the phase encoding direction are optimized to reduce a blurring due to the filtering effect of GRAPPA on high frequency region of k-space.

**14:50 2414. Self-Calibrating Radial Generalized SENSE**

*Roland Bammer*, *Karl K. Vigen*, *Klaas P. Pruessmann*, *Michael Markl*, *Michael E. Moseley*

1Stanford University, Stanford, California, USA; 2ETH and University of Zurich, Zurich, Switzerland

Radial k-space trajectories excessively oversample the k-space origin and provide higher resolution per unit time than Cartesian imaging. Hence, they are inherently suited for autocalibration in generalized SENSE reconstructions and therefore of great advantage in the presence of bulk physiologic motion, where conventional calibration scans can be unreliable. Using the GSENSE reconstruction our phantom and in-vivo experiments showed only minimal distortions for large reduction factors (R ~ ncoils). Hence, radial scanning in combination with GSENSE appears promising for applications where high temporal resolution is desired, such as in cardiac imaging or pharmacokinetic MRI studies.

**15:00 2415. LS_Nufft Based SENSE Reconstruction for Polar K-Space Trajectory**

*Bida Zhang*, *Kai Zhong*, *JianMin Wang*, *Yan Zhuo*

1Siemens Mindit Magnetic Resonance Ltd., Shenzhen, Guangdong, People's Republic of China; 2The Chinese Academy, Beijing, People's Republic of China

Most SENSE reconstruction methods for arbitrary k-space trajectories are combined with the conventional gridding methods i.e. Kaiser-Bessel gridding or GFFT. In this abstract, a more efficient gridding method, LS_Nufft, was introduced and combined with the conjugate gradient iterative reconstruction algorithm. The new approach was evaluated both in phantom and in vivo with polar k-space trajectory. For a 128x128 image reconstructed from 8-channel raw data, the reconstruction time was approximately 1.7s per iteration step. The LS_Nufft results demonstrated smaller image error and faster speed compared with conventional gridding methods.

**15:10 2416. Self-Calibrated Spiral SENSE**

*Yongxian Qian*, *Zhenghui Zhang*, *Yi Wang*

1University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Current SENSE imaging requires a calibration scan to estimate the coil sensitivities. Prior SMASH work demonstrated that self calibration using a lower resolution image constructed from the k-space center data can eliminate the limitation associated with the calibration scan. In this paper, we present a self-calibrated spiral SENSE imaging method.

**15:20 2417. Is Parallel MRI Without a Priori Information Possible?**

*Martin Blaimer*, *Felix Breuer*, *Robin M. Heidemann*, *Matthias Müller*, *Mark A. Griswold*, *Peter M. Jakob*

1Universität Würzburg, Würzburg, Germany

In general, parallel MRI reconstruction algorithms are based on a-priori information for coil sensitivity calibration. This information can be obtained before or after the accelerated scan by an additional experiment or during the accelerated scan using a variable density acquisition scheme. Therefore additional scan time is necessary to obtain this a-priori information. In this abstract it is shown, that in principle it is feasible to use the GRAPPA-Operator formalism to derive the reconstruction parameters directly from the undersampled data set. Compared to other parallel MRI implementations no a-priori information is necessary, resulting in more relaxed requirements for parallel MRI methods.

**E-POSTERS: Cerebral Disease Models**

**2418. MRI Detection of Neuronal Degeneration in Superoxide Dismutase 1 G93A GH Transgenic Mouse Model of Amyotrophic Lateral Sclerosis**

*Qing Yang*, *Dawei Zang*, *Hong Xin Wang*, *Gary Egan*, *Elizabeth Lopes*, *Surindar Cheema*

1The University of Melbourne, Melbourne, Victoria, Australia

Amyotrophic lateral sclerosis (ALS) is a common form of motor neuron disease (MND). The superoxide dismutase 1 (SOD1) transgenic mouse is a widely used animal model of human ALS/MND. In this study, we used MRI to detect neuronal degeneration in this model. MRI T2 hyperintensities of various nuclei were found in the brain stem. Histology analyses of the corresponding sites revealed marked neuronal degeneration. Atrophy were also observed in the brain stem, cerebellum and cortex. MRI can be used as a non-invasive method to investigate disease progression and response to novel drug therapies in the SOD1 mice model of ALS.
2419. Early Cerebral MR Perfusion Changes in the Acute SIV Infection Primate Model of neuroAIDS
Julian He1, Helen D’Arceui1, Jane Greco1, Margaret Lentiz2, Eva Ratai1, John Kim1, Robert Fuller1,
P Sehgal2, Susan Westmoreland2, Kenneth Williams3, Alex de Crespiigny4, R G. Gonzalez2
1Massachusetts General Hospital, Boston, Massachusetts, USA; 2NERPRC, Southborough, Massachusetts, USA; 3BIDMC, Boston, Massachusetts, USA

Perfusion Magnetic Resonance Imaging (PWI) in a macaque model of neuroAIDS (simian immunodeficiency, SIV; analogous to human immunodeficiency, HIV) has been used to measure regional cerebral blood volume (CBV) and flow (CBF) and shown different patterns of perfusion change in the acute SIV infection as early as 2 and 4 weeks after inoculation with SIV. Significantly increased CBV was found at 2 and 4 weeks post infection, thereby providing supportive evidence to the current theory of inflammatory central nervous system changes due to HIV/SIV neuroinvasion.

2420. A Quantitative Comparison of Unilateral versus Bilateral Neural Stem Cell Transplantation in the 3-nitropropionic Acid Model of Huntington’s Disease by Contrast Agent-Enhanced MRI.
Jasdeep K. Sandhu1, T.J. Roberts1, J Price2, T.J. Meade2, S.C.R Williams1, M Modo1
1Kings College London, London, UK; 2Northwestern University, Evanston, Illinois, USA

A quantitative comparison of the effects of unilateral versus bilateral contrast-enhanced MHP36 stem cell transplants in the 3-nitropropionic-acid model of Huntington’s disease were assessed with MRI. Grafts were identified as hypointensities in SEME scans. The loading of stem cells with GRID provides a means to track survival, migration and integration of transplanted cells In vivo. Grafts show a dynamic spatial and temporal evolution over time, with a progressive increase in total graft volume in both transplant groups. This study suggests that unilateral transplantation might provide a means to deliver stem cells to both hemispheres in models of bilateral damage.

2421. Diffusion Weighted Imaging in a Rat Closed Head Injury Model Gives New Insights in the Understanding of the Neuroprotective Effect of 2-farnesyl Thiosalicylic Acid, FTS, a Synthetic Ras Inhibitor
Daniele Marciano1, Esther Shohami2, Yoel Kloog3, Gad Goelman4
1Israel Institute of Biological Research, Ness-Ziona, Israel; 2Hebrew University School of Pharmacy, Ein-Karem - Jerusalem, Israel; 3Tel-Aviv University, Ramat Aviv - Tel Aviv, Israel; 4Hadassah Hebrew University Hospital, Jerusalem, Israel

Synopsis: DWI and T2 imaging are MRI techniques, which allow distinction between cytogenic and vasogenic brain edema after TBI. DWI also distinguishes between extracellular diffusion and capillary perfusion. CBF impairment and BBB breakdown are main factors in TBI damages. A MRI study was performed in a TBI rat model, to understand the previously observed pharmacological beneficial effects of FTS, a Ras inhibitor. FTS increases the cerebral perfusion and diffusion which were both diminished in untreated rats. The FTS rescue of the brain maybe attributed to a K channel mediated vasodilatation beside the assumed decrease in Ras-dependent MAPK mediated neuroinflammatory response.

2422. Magnetic Resonance Imaging of Stickelback Fish Brains Using Cryo-Cooled Surface Coils
Jolinda C. Smith1, Ray L. Nunnally1, Katrina McGuigan1, John H. Postlethwait1
1University of Oregon, Eugene, Oregon, USA

We have built liquid nitrogen cooled surface coils and used them to image the brains of stickleback fish. The receive-only coils had a 25 mm inner diameter and were inductively coupled to a matching loop. The coils show a significant improvement in signal to noise over air-cooled coils with identical dimensions. The fish, which ranged in size from 4 to 6 cm, were imaged ex vivo at 3T. High resolution images showing detailed neuroanatomy were obtained, and several brain structures were identified. This work demonstrates the feasibility of high-resolution imaging of small fish at 3T.

2423. MRI Visualization of Electrode Recording Cylinder Trajectories
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The implantation of microelectrodes in the brain is a valuable method for recording neuronal activity in vivo. The success of this method depends on accurate placement of the microelectrodes. This can be challenging, particularly for targeted brain regions that are below the cortical surface, because stereotaxic locations can vary between individuals. Recently, magnetic resonance imaging has gained widespread acceptance for this purpose, but typically provides only a qualitative account of anatomical structures that appear below a recording cylinder. Here we present a novel technique that uses MRI to quantitatively determine electrode trajectories and their intersection with anatomy.
E-POSTERS: Experimental Cerebral Ischemia

2424. Sustained Postischemic Hyperperfusion is Associated with Reversal of ADC Abnormalities Following Transient Focal Cerebral Ischemia in Rats
Juergen Frank Bardutzky, James Bouley, Marc Fisher, Timothy Duong
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Reports on the effect of early postischemic hyperperfusion on tissue fate have been contrary, and both beneficial and harmful effects have been reported, depending on severity and duration of prior ischemia. Using serial perfusion- and diffusion-weighted magnetic resonance imaging in 7 SD rats undergoing 60min focal cerebral ischemia, we observed that reversal of ADC abnormalities has been associated with a sustained hyperperfusion beginning immediately after reperfusion and lasting at least up to 24hr. In addition, the extent of hyperperfusion was more pronounced at later time points, i.e. 24hr, exceeding more than 135% of the LH.

E-POSTERS: Brain MR Spectroscopy: Methods and Models

2425. SNAPSHOT: A Rapid 13C MRS Technique for Clinical Neurospectroscopy
Kent Harris, Pratip Bhattachayra, Alexander Peter Lin, Brian Schweinsburg, Brian David Ross
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A 13C MRS protocol is described which permits rapid determination of metabolic enrichment profiles of the human brain. In 10 consecutive human subjects (7 controls and 3 patients), MRI, 1H and natural abundance 13C MRS was performed (20 mins) and 1-13C glucose and/or 1-13C acetate were administered. 90 - 110 minutes later, MRI, 1H MRS and 13C MRS were repeated. Automated data processing provided quantitative 13C metabolite profiles from which an objective report could be provided in minutes.

2426. Functional Proton Magnetic Resonance Spectroscopy of the Human Primary Visual Cortex: Metabolite and Neurotransmitter Concentrations
Rachel Katz-Brull, David C. Alsop, Robert P. Marquis, Robert E. Lenkinski
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The neurochemical correlates of the BOLD response in fMRI studies are not fully understood. To test the hypothesis that during stimulation the level of glutamate increases due to higher CMRglc(ox), 1H-MRS and fMRI of the human V1 were performed at 3T using an optimized 1H-MRS acquisition and the same timing of the visual stimulation paradigm. The level of brain metabolites, including lactate, glucose, glutamate, and glutamine was similar before, during, and after stimulation. These results suggested that the changes in these metabolites were below the detection level, or that these metabolites and neurotransmitter are under tight regulation.

2427. Simultaneous Detection of GABA, Glutamate and NAA using MEGA Editing and PRESS Localization
Marzena Wylezinska, Peter Jezzard
University of Oxford, Oxford, UK

In this work we describe a protocol that allows spatially localized simultaneous detection of γ-aminobutyric acid (GABA), Glutamate + Glutamine (Glu + Gln), and N-acetyl aspartate (NAA). The method is based on MEGA-PRESS editing using a specially designed double-banded 180 RF pulse. Using NAA as a reference LCM model has been incorporated into the analysis of the edited spectra. Obtained concentrations of GABA and Glu+Gln in iccipital lobe in N=5 control subjects were 1.36 mM and 13.34 mM respectively.

2428. Magnetization Transfer Spectroscopy of Metabolites and Macromolecules in Human Brain In Vivo
Mary Anne McLean, Robert J. Simister, Gareth J. Barker, John S. Duncan
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Off-resonance magnetization transfer spectroscopy was implemented on a 1.5T General Electric scanner. Spectra were collected at frequency offsets of 2.5 and 30 kHz, with and without an inversion pulse (TI = 650 ms) to null small metabolites. In human frontal lobe, the macromolecule peaks were virtually unaffected by the MT pulses; but all small metabolites showed a trend of reduced signal with the 2.5 kHz pulses. In agreement with previous studies, this was most marked for creatine, which showed a 13% reduction when compared to the 30 kHz data.
2429. **31P MRS in Human Brain at 4T and 7T: Signal-to-Noise Ratio and Spectral Resolution Comparisons**

Hongyan Qiao¹, Xiaoliang Zhang¹, Xiaohong Zhu¹, Wei Chen¹
¹University of Minnesota, Minneapolis, Minnesota, USA

In vivo 31P spectra were acquired from the human visual cortex at 4T and 7T with the same experimental conditions. The relaxation times, RF coil Q factors and signal-to-noise ratios at the two field strengths were measured. 31P sensitivity was doubled at 7T compared to 4T. Therefore, the field dependence of 31P sensitivity was better than linear increase. Nevertheless, the linewidth broadening of PCr peak was less than linear relationship with B₀ and T₁ of PCr is field independent. The results indicate the great advantages at high field for improving 31P MRS quality in both sensitivity and spectral resolution.

2430. **An Objective Test for Assessment of Low Back Pain Using Neurospectroscopy**

Carolyn E. Mountford¹, Philip J. Siddall², Peter T. Stanwell², Ray L. Somorjai³, Brion Dolenko¹, Sasha Nikulin³, Uwe Himmelreich¹, Cynthia L. Lean¹, Annie Woodhouse², Michael J. Cousins²
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Neurospectroscopy was undertaken on 32 subjects with chronic low back pain and 33 volunteer controls. For each person, three locations of the brain were examined: prefrontal cortex, anterior cingulate cortex and thalamus. The MR spectra were analysed using classifiers based on a statistical classification strategy. The differences in MR spectra in the brains of people with low back pain allowed the distinction from volunteer controls to be made with an accuracy of 100% for anterior cingulate cortex, 99% for thalamus and 92% for prefrontal cortex. The method provides an accurate, robust and objective technique for the assessment of pain.

2431. **N-acetylaspartate within Frontal and Parietal White Matter Differentially Predicts Intellectual Functioning in Normal Brain**

Rex E. Jung¹, Laura Rowland¹, Paul G. Mullins², John Lauriello¹, Juan Bustillo¹, Ronald A. Yeo¹
¹University of New Mexico, Albuquerque, New Mexico, USA; ²MIND Institute, Albuquerque, New Mexico, USA

Proton Magnetic Resonance Spectroscopy (1H-MRS) techniques have been associated with measures of intelligence (IQ) in clinical and normal subjects. We sought to determine concurrent relationships between IQ and NAA sampled from multiple brain regions. We scanned 20 normal subjects, administered a well-validated measure of intelligence, and obtained spectra from four brain regions: caudate nucleus, cerebellum, frontal-, and parietal-white matter. Stepwise multiple regression revealed concurrent positive relationship between parietal NAA and IQ (t=4.6, p<.001) and negative relationship between frontal NAA and IQ (t=-3.2, p=0.006). These results suggest that regionally optimal levels of NAA may underlie individual differences in higher cognitive functioning.

2432. **Quantitative Neuropathological Correlates of Change with Primate Brain NAA/Cr**

Margaret Rose Lentz¹, John P. Kim¹, Susan V. Westmoreland¹, Jane B. Greco¹, Eva M. Ratai¹, Robert A. Fuller¹, Julian He¹, Prabhat Sehgal¹, Andrew A. Lackner¹, Eliezer Masliah¹, R. Gilberto Gonzalez¹
¹Harvard Medical School/ Massachusetts General Hospital, Charlestown, Massachusetts, USA; ²New England Primate Research Center, Southborough, Massachusetts, USA; ³New England Primate Research Center, Charlestown, Massachusetts, USA; ⁴Tulane National Primate Research Center, Covington, Louisiana, USA; ⁵University of California, San Diego, La Jolla, California, USA

A transient decline in the neuronal metabolic marker NAA/Cr was found to follow the peak in viremia and its subsequent control during acute SIV infection. During this period, quantitative neuropathologic analyses revealed a decline in synaptophysin, but not in neuronal counts, calbindin or MAP2. NAA/Cr and synaptophysin are independently used as markers for neuronal health. This study shows their similar patterns of change during acute SIV infection. Declines in NAA/Cr observed by in vivo and ex vivo 1H MRS may be indicative of early neuronal injury, not neuronal loss. Results show this injury may be related to presynaptic dysfunction.

2433. **Changes of Mobile Lipids in Rat Brain after Transient Focal Ischemia Observed by Long Echo-Time In Vivo 1H Magnetic Resonance Spectroscopy**

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Cerebral magnetic resonance visible lipids (MRVL) are potentially useful in providing diagnostic and prognostic information for neurological diseases such as brain tumor and stroke. Long echo-time in vivo 1H MRS was used in this study to monitor the changes of cerebral metabolites, including lipids, in a rat model of transient middle cerebral artery occlusion. It is shown that the MRVL are observable in the ischemic tissues starting from 1 day postischemia, and increase progressively hereafter up to 4 days postischemia. The origin of the MRVL needs further investigation, however, they most likely come from mobile lipids or intra-cytoplasm lipid droplets.
A NMR Study of Trifluoperazine Crossing Blood-Brain-Barrier Due to P-Glycoprotein Modulation
Paul C. Wang1, Adorjan Aszalos1, Ercheng Li1, Renshu Zhang2, Huafu Song1, Raymond Malveaux1
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Potential for drug-drug interactions for patients treated with a combination of therapies is high. Such interactions may cause changes in pharmacokinetics, especially for drugs with narrow therapeutic indices. Drug-drug interactions can cause by interference of P-glycoprotein (Pgp) at blood-brain-barrier level. MRS was used to detect a fluorinated drug, trifluoperazine (TFP), in combination with an immune suppressor, cyclosporin A, to monitor the drug penetration through the BBB due to Pgp modulation. Results showed concomitantly administered Pgp modulator enhanced the amount of TFP, an antipsychotic drug, to cross BBB. It also demonstrated that Pgp modulation is more problematic for older rats.

In Vivo Monitoring of Alcohol Uptake Kinetics in Rat Brain
Adolf Pfefferbaum1, Elfar Adalsteinsson2, Edith V. Sullivan2, Dirk Mayer2, Napapon Sailasuta1, Ralph Hurd3
1SRI International, Menlo Park, California, USA; 2Stanford University, Stanford, California, USA; 3GE Medical Systems, Menlo Park, California, USA

Individual differences in alcohol uptake kinetics may contribute to the development of problem drinking. The animal model of alcohol preferring (P) and non-prefering (NP) Wistar rats offers an opportunity to study alcohol uptake kinetics in vivo under controlled conditions. Here we report the feasibility of monitoring brain ethanol uptake and kinetics in the native Wistar stock.

Florian Schubert1, Clemens Elsner1, Alfred Link1, Frank Seifert1, Monika Walzel1, Herbert Rinneberg1
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For MR spectra at shorter echo times spectral processing often includes background fitting using models that may include errors not accounted for by the Cramér-Rao lower bounds. Using our semi-parametric spectrum processing method we determined uncertainties of the parameter estimates by accommodating the uncertainty contributed by the background model. The method was tested on simulated proton spectra of varying background and different SNRs, and applied to brain spectra. Inclusion of background uncertainty appears important for evaluating goodness of fit and comparing fitting methods. Even at medium echo times the contribution of the uncertainty of the background model cannot be neglected.

Using Peak-Enhanced 2D-Capon Analysis with Single Voxel Magnetic Resonance Spectroscopy to Estimate T2* for Metabolites
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Single voxel proton Magnetic Resonance Spectroscopy (MRS) is typically used to quantify metabolites present in the human brain. By convention, the result of a single voxel MRS scan is an MRS absorption spectrum in which the concentration of each metabolite can be determined on the basis of its frequency representation in the spectrum. By using two-dimensional Capon analysis on the MRS data, information on the damping characteristics of each metabolite can also be determined. This damping information may be used to estimate the T2* characteristics of each metabolite providing useful clinical information for single voxel MRS studies.

Subspace-based MRS Data Quantitation of Multiplets using Prior Knowledge
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Automatic and accurate quantification of MRS signals is essential before converting the estimated signal parameters into biochemical quantities. Many subspace-based algorithms for parameter estimation have been developed. They directly estimate the model parameters by means of robust linear algebra tools and can be fully automated. However, they allow little inclusion of biochemical prior knowledge about the model parameters, which is important for resolution and accuracy. Here a new subspace-based method for parameter estimation is presented: KNOB-SVD/TLS. Extensive simulation and in vivo studies show that KNOB-SVD/TLS outperforms the currently used subspace-based methods in terms of robustness and accuracy.

Automated Model Fitting of In Vivo 1H-MR Spectroscopic Imaging Data of the Human Prostate
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Model fitting has been applied to quantification of MRS data of the brain for various field strengths and nuclei. To quantify MRS data of the prostate however, mainly simple integration or line fitting is used. In this study, we transfer linear combination fitting to clinical prostate data at 1.5 and 3 T. The quantification benefits of the appropriate description of the complex pattern of citrate, a strongly coupled spin system, which is included in the basis set as a simulated model signal. In combination with a robust determination of starting values, reliable processing of 3D-MRSI data is achieved.
**2440. Assessment of the Padé Approximant for Quantifying Proton MR Spectroscopy Data**

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The Padé Approximant is a mathematical method used to estimate the convergence of a slowly converging series, such as the Fourier series. In this work it was applied to the MR spectroscopy, providing a route to parameter estimation. The results of the Padé were compared with several other spectroscopic quantitation methods and found to be of at least as accurate as the other methods. The effects of spectroscopic lineshape on quantitation accuracy was also discussed in this work.

**2441. NMR Dynamics Studies of Low-Affinity Drug Interaction with Proteins: Experimental Validation of New Protein Theory of General Anesthesia**

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Application of magnetic resonance in medicine is not limited to radiology. The abstract describes an MR study that may have potential impact on anesthesiology and other medical disciplines that involve low-affinity drug actions in general (e.g., treatment of alcoholisms).

**2442. Establishing the Safety of Clinical 13C MRS with Proton Decoupling**

Tsuyoshi Matsuda1, Moyoko Saito2, James Tropp3, Tetsuji Tsukamoto1, Raidy Tom1, Toshirou Inubushi1, Pom Sailasuta3, Toshiharu Nakai2

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We need to pay compensation for 13C-1H decoupling technique, which is temperature elevation in human body. Shorter sampling duration allows less temperature increase because decoupler irradiates high peak power at during collection of 13C NMR signals. We determined decoupling time to 64msec by observing the FID of 13C in vivo. When we obtained the spectrum from normal temperature patient under the our mentioned conditions, it is thought that protein denaturation is not incurred in cells during heat shock at proton decoupler because elevation of temperature is below one-degree under the one-hour examination from our heating experiments.

**E-POSTERS: Neuro MR Spectroscopy**

**2443. Annual Decrease in N-acetylaspartate /Creatine Correlates with the Progression of Alzheimer's Disease**

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We performed annual H-1 MRS exams in 69 cognitively normal elderly, 45 people with amnestic mild cognitive impairment (aMCI) and 41 with Alzheimer's disease (AD), to compare the annual change in metabolite ratios across the whole spectrum of cognitive performance. The annual decrease in NAA/Cr was greater in patients with AD than normal. Annual decrease in NAA/Cr was associated with the annual decrease in DRS and CDR scores in the whole group of cognitively impaired patients and in patients with AD. Serial measurements of NAA/Cr may be a useful bio-marker of disease progression in AD, starting from the earliest stages.

**2444. In Vivo Proton MR Spectroscopy in Evaluation of Dementia**

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Aim of our study was to assess the role of proton MR Spectroscopy (1H MRS) in patients with dementia and to characterize progression of the dementing process (a preliminary study in India). Reduction in N-acetyl aspartate (NAA/Cr) was noted in all dementia patients studied. Increase in myoinositol (mI/Cr) and decreased NAA/Cr helped distinguish Alzheimer’s disease (AD) from other dementias except Fronto-temporal dementia (FTD). These ratios also helped in assessing progression of the disease process. The metabolite changes as assessed by MRS predate structural changes and if detected early may help limit neuronal loss if appropriate interventions are incorporated.
ALS is a devastating neurological disorder of the upper (UMN) and lower (LMN) motor neuron, whose pathophysiology has been investigated by in vivo MRS. Though metabolite ratios are commonly used to express relative changes in MRS data, there is an inherent pitfall in this approach: the underlying assumption that the denominator in the ratios (usually CR) is constant and reliable may not always be true. In this study, we investigate the effects of exogenous CR supplementation on MRS-derived metabolic markers (NAA/CR) of ALS.

Improving Sensitivity of MRS by Motion-Related Error Correction in Patients with Huntington’s Disease

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Involuntary head movements in patients with hyperkinetic disorders, such as Huntington’s disease (HD), result in an increase of the goodness of fit parameter (%SD) calculated by the LCModel program for the quantitation of brain metabolites by MRS. A comparison of the NAA/Cr ratio in the striatum for 12 HD patients and 10 normal controls showed no statistically significant difference. However, when these results were corrected for %SD, the difference became statistically significant (p = 0.001). These results suggest that taking into account the %SD parameter could help identify quantitative metabolic differences in patients with hyperkinetic disorders.

1H MRS Study of Acute Lorazepam in Healthy Human Brain

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Many patients are given the benzodiazepine lorazepam to ease MR procedures. But the effects of this agent on 1H MRS metabolites are unknown. 1H MRS was acquired from gray and white matter in 12 healthy adult males scanned 30 min after oral lorazepam, then a week later with no drug. Eight subjects were rescanned with no drug after a further week. No significant differences were found between lorazepam and no drug metabolite measures. Frontal gray matter Cho was, however, slightly elevated in the second over the first no drug scan, allowing possible sub-acute effects of single-dose lorazepam on Cho.

Abnormal H-MRS Suggests Involvement of the Thalamus in Diabetic Neuropathy

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There is scant information with regard to brain deep nuclei involvement in diabetic neuropathy (DN). Sixteen type-1, male diabetic patients (8 with and 8 without DN) and 8 controls underwent proton MRS at both short and long echo-times. Spectra obtained from a voxel covering the posterior lateral thalamic nucleus showed lower NA/Cho in DSP patients compared to others (DSP vs non-DSP, p=0.036; DSP vs HV, p=0.015) at long TE. No significant differences were observed at short TE. These novel findings suggest thalamic sensory neuronal dysfunction in patients with ‘peripheral’ diabetic neuropathy without overt neuronal loss.

Neuroprotective Effects of Growth Hormone against Hypoxic-Ischemic Brain Injury in Neonatal Rats: 1H Magnetic Resonance Spectroscopic Study

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1Asan Medical Center, University of Ulsan College of Medicine, Seoul, Republic of Korea; 2Asan Institute for Life Science, Seoul, Republic of Korea

Caspases are believed to play a key role in the delayed neuronal cell death observed in the rat brain after hypoxic-ischemic insult. Caspase inhibitors have been developed as anti-apoptotic agents. This study was purposed to evaluate the effects of growth hormones as caspase inhibitors on hypoxic-ischemic injury in neonatal rat brain with 1H-MR spectroscopy. The results of this study are that growth hormone exerts neuroprotective effect in cerebral hypoxic-ischemic injury probably by inhibiting apoptosis especially in early stage after insult. Growth hormone as a caspase inhibitor can be therapeutic value to prevent the brain injury.
We studied 21 Huntington disease (HD) patients and 15 controls using quantitative diffusion imaging and MR spectroscopy and correlate the results. Overall, HD patients have higher diffusion than the normal controls, especially in the caudate. The Cho in motor strip was elevated compared to the gray matter in the occipital lobe. Diffusion measurements are robustly correlated to several metabolites. Repeat studies of HD patients for four consecutive months did not reveal changes. The diffusion values are increased in HD patients suggestive of microstructural damage in the brain tissue. This increase is correlated with a decrease in NAA and Cr.

Multivoxel MR spectroscopy of the brain were analyzed in 11 patients with Rasmussen’s encephalitis to detect regional difference. NAA/Cho, Cho/Cr and NAA/Cr ratios were calculated for 5 regions of both hemispheres. There was a significant difference in all three ratios between the affected and contralateral hemispheres. No significant difference is detected for brain regions. Duration of seizure, age of patient and MR imaging pattern did not produce a significant effect. Results suggest that Rasmussen’s encephalitis is a hemispheric disease, not a localized pathology, even early in disease process.

We evaluated the levels of cerebral lactate (Lac) and apparent diffusion coefficients (ADC) in the white matter of infants with perinatal asphyxia during the early postnatal period. A significantly higher ratio of Lac/Choline was found in patients with an abnormal or fatal outcome compared to patients who had a normal outcome (P = .02); no significant differences were found regarding ADC values (P = .96). Our findings suggested that metabolic changes do occur within the white matter of neonates with perinatal asphyxia and that proton MRSI identifies neonates with adverse clinical outcome.

1H MRS abnormalities are documented in multiple brain regions in adult schizophrenia. Elevated Cho has been predicted in younger-onset patients. We acquired 1H MRSI (TR/TE = 3000/13 ms) of the brain in childhood-onset schizophrenics and age-matched healthy controls. Elevated Cho was found in superior anterior cingulate, frontal cortex, and caudate head in patients, supporting the prediction and the “membrane hypothesis” of schizophrenia. In superior anterior cingulate, Cr was also elevated, possibly due to cell-energetic disturbances. NAA was depressed in thalamus in male patients only, indicating possible neuron dysfunction.

Twenty-three boys with autism and a control group of twenty-five healthy children were scanned using proton magnetic resonance spectroscopic imaging (MRSI) at 3.0 tesla. Spectra were acquired with a multi-slice inversion-recovery spin-echo MRSI sequence (TI/TE/TR=230/135/1800 ms, ~1-cc voxels). Metabolite concentrations were estimated in components of the limbic system, specifically the anterior cingulate, hippocampus and anterior thalamus. A significant region x hemisphere x diagnosis interaction was observed for both NAA and Cre. Cho levels did not differ between groups. These findings provide evidence of metabolic abnormalities in components of the limbic system in autism.

Hydrocephalus results in dramatic but reversible compression of the white matter of the brain. To elucidate the underlying physiological mechanisms we applied quantitative MRS and DTI. No change in the principle brain metabolite concentrations was observed, however, DTI showed increase fractional anisotropy in the periventricular white matter. We conclude that hydrocephalus is a disorder of intracellular osmo-regulation with fluctuations in cell volume accounting for the reversible brain tissue volume.
2456. **Propylene Glycol is Essential in the LCModel Basis Set for Paediatric Brain ¹H-MRS**

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It is not uncommon for newborn infants to be treated with a drug preparation containing propylene glycol. Propylene glycol is a pharmaceutical solvent for preparations including anticonvulsants, sedatives, and vitamin infusions. The presence of propylene glycol in the brain can seriously compromise LCModel’s ability to quantify lactate. The addition of propylene glycol to the standard LCModel basis set eliminates this problem. Since the accurate and proper quantitation of lactate is clinically very important, we suggest the inclusion of propylene glycol in the basis set when using LCModel to interpret paediatric ¹H-MRS results.

2457. **Diffusion Tensor Imaging of PET Glucose Hypometabolic Cortex in Children with Intractable Partial Epilepsy**

_Malek Makki¹, Csaba Juhasz¹, Bharathidasan Jagadegsan¹, Otto Muzik¹, Diane Chugani¹, Harry Chugani²_

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Four children with intractable epilepsy and normal structural MRI underwent DTI and 2-deoxy-2[¹⁸F]fluoro-D-glucose positron emission tomography (FDG-PET) scans as part of their pre-surgical evaluation. The purpose of this investigation was to examine changes of ADC and FA in cortical areas identified as structurally normal but showing glucose hypometabolism on FDG-PET. We found decreased FA in 12/16 hypometabolic regions, and increased ADC values in 11/16 hypometabolic regions identified on the PET scans. This preliminary study suggests that DTI may be a useful complementary method to identify functionally abnormal regions in patients with non-lesional intractable partial epilepsy.

E-POSTERS: MR Spectroscopy Techniques

2458. **Symmetric-Sweep Spectral-Spatial RF Pulses for Spectral Editing**

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Spectral-spatial radiofrequency (SSRF) pulses allow simultaneous selection in both frequency and spatial domains. These pulses are particularly important for magnetic resonance spectroscopy applications where suppression of large water (and lipid) resonances is critical. In this abstract we demonstrate a new design for non-linear-phase 180-degree SSRF pulses that can be used for spectral editing of lactate. The novel feature of the pulses is that the spectral profile develops as a symmetric sweep, from the outsides of the spectral window towards the middle, so that coupled components are tipped simultaneously and over a short interval.

2459. **Reproducibility of Multi-Slice 2D Proton MRSI at 3.0 T**

_Tim J. DeVito¹, Rob Nicolson¹, Yves Bureau², Peter C. Williamson¹, Dick J. Drost¹_

¹University of Western Ontario, London, Ontario, Canada; ²Lawson Health Research Institute, St. Joseph’s Health Care, London, Ontario, Canada

Inter-subject and intra-subject variability of quantified metabolite amplitudes were assessed at 3.0 tesla. Nine healthy adults were scanned twice in the same day using 2-dimensional proton magnetic resonance spectroscopic imaging (MRSI). Spectra were acquired with a multi-slice inversion-recovery spin-echo MRSI sequence (TI/TE/TR = 230/135/1800ms, ~1-cc voxels). Intra-subject and inter-subject coefficients of variation (CV) were measured for NAA, Creatine and Choline in nine different brain regions. Mean intra-subject CVs across all voxels examined were 12.6% (NAA), 24.6% (Cre) and 18.4% (Cho), while inter-subject CVs were slightly higher: 17.2% (NAA), 25.0% (Cre) and 21.3% (Cho).

2460. **Single-Shot ¹³C{¹H} Polarization Transfer Spectroscopy with 3D Proton Localization and Double Adiabatic Spin Echoes**

_Shizhe Steve Li¹, Martin J. Lizak², Alan Wayne Olson², Jun Shen¹_

¹NIMH, Bethesda, Maryland, USA; ²NINDS, Bethesda, Maryland, USA

A new method is presented to obtain ¹³C spectroscopy with polarization transfer, single-shot proton localization, and outer volume suppression. 3D spatial localization is achieved using two 90° slice-selective non-adiabatic pulses and a pair of AFP pulses for slice-selective adiabatic refocusing. All other pulses in the polarization transfer sequence are adiabatic. The experiments were performed on a 4.7T horizontal magnet with surface coils using ¹³C labeled glucose and glutamate phantoms. The results demonstrated the excellent localization and sensitivity.
2461. A Method for Interleave Measurements of $^1$H, $^1$H-$^13$C, and $^{31}$P Spectra from the Same Localized Area at 4.7T Wholebody System  
Fumiyuki Mitsumori¹, Nobuhiro Takaya¹, Hidehiro Watanabe¹  
¹National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan

We developed a method for interleave measurements of $^1$H, $^1$H-$^13$C, and $^{31}$P spectra from the same localized area at 4.7 T wholebody MRI system. Three surface coils, two of which tuned for quadrature $^3$P, and one for $^1$C, was integrated with a $^1$H TEM coil for head. We added up a spectral editing feature for $^1$H by $^1$C on a combined pulse sequence of STEAM and ISIS for $^1$H and $^3$P measurements. Performance of $^1$H, indirect $^1$C, and $^{31}$P measurements was proved either on the $^13$C-labeled and natural abundance phantom sample. $^1$C decoupling was also possible.

E-POSTERS: Diffusion Acquisition Techniques

2462. PROPELLER EPI: Application to Diffusion Tensor Imaging  
Fu-Nien Wang¹, Teng-Yi Huang¹, Fa-Hsuan Lin¹, Hsiao-Wen Chung², David S. Tuch¹, Ming-Chung Chou², Cheng-Yu Chen³, Kenneth K. Kwong¹  
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In this study we present a successful implementation of Propeller EPI, with appropriate phase correction and echo weighting for effective artifact removal. Applications to diffusion tensor imaging (DTI) with little geometric distortion are demonstrated for human brain near the skull base.

2463. Ramifications of Isotropic Sampling and Acquisition Orientation on DTI Analyses  
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¹Brown University, Providence, Rhode Island, USA; ²University of Edinburgh, Edinburgh, UK; ³Brown Medical School, Providence, Rhode Island, USA

Six diffusion tensor imaging datasets of a normal volunteer were acquired and analyzed to investigate differences in analysis results due to acquisition orientation and sampling anisotropy. We found relatively small differences in scalar analyses as a function of sampling anisotropy. We found even smaller differences due to acquisition orientation. This suggests that, under some conditions, isotropic sampling is not needed for scalar analyses, and acquisition orientation is not significant. However, for analyses incorporating connectivity information we found significant differences; anisotropic sampling can lead to orientation-related bias and isotropic sampling may be indicated.

2464. Improvement in Diffusion MRI at 3T and Beyond with the Twice-Refocused Adiabatic Spin Echo (TRASE) Sequence  
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For diffusion MRI, the SNR gains afforded by high field MR scanners ($\geq$3T) offer the promise of improved resolution, but the problems of eddy currents, B1 inhomogeneity, and RF power deposition increase with field strength accordingly. It has been shown that eddy-current-induced image distortions can be effectively reduced by using a twice-refocused spin echo (TRSE) sequence. For further improvement at high field, the pair of refocusing RF pulses in the TRSE sequence can be replaced with adiabatic full-passage RF pulses, which offer better B1 homogeneity. This twice-refocused adiabatic spin echo (TRASE) sequence is demonstrated at 3T.

2465. Minimization of Eddy Current Artifacts in Diffusion Tensor Imaging by a STEAM-EPI Sequence at 3.0 Tesla  
Guenter Steidle¹, Gunther Helms¹, Fritz Schick¹  
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Using a stimulated echo instead of a spin echo preparation for diffusion tensor imaging of tissues with a low T1/T2 ratio leads to an increased SNR for large b-values especially at higher field strength. However, high diffusion gradient pulses cause significant eddy currents creating severe image artifacts in diffusion-weighted maps. In this work, additional gradient waveforms were implemented in a diffusion-weighted stimulated echo EPI sequence for minimizing the influence of given eddy currents without any increase in the minimum TE or acquisition time. Diffusion map calculations from diffusion tensor could be performed without significant image distortion.

2466. Experimental Verification of Increased Diffusion Sensitivity with Hyperechos  
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In a recent paper, we presented theoretical results that a two-pulse diffusion weighted (DW) hyperecho sequence has the advantage of producing equal or greater SNR than a standard DW stimulated echo sequence with equivalent diffusion weighting. In theory, the two-pulse hyperecho sequence has greater diffusion sensitivity than the stimulated echo sequence. This study presents experimental verification that data acquired with a hyperecho acquisition produce an improved sensitivity of the local anisotropy as seen by increased FA values obtained from fractional anisotropy maps. Results are shown in two normal human brains.
**2467. An EPIK Navigation Towards High-Resolution Diffusion-Weighted Imaging**

Rita Gouveia Nunes1, Peter Jezzard1, Heidi Johansen-Berg1, Tim E. J. Behrens1, Stuart Clare1
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Interleaved Echo Planar Imaging (IEPI) can be used to produce high-resolution Diffusion-Weighted Images (DWI). However, DW makes the images particularly sensitive to patient motion, resulting in severe artefacts. These problems can be overcome by acquiring a 2D navigator echo after each interleave. Such an approach is not efficient, since the navigator does not contribute signal to the image. We propose the use of a self-navigated sequence based on IEPI which enables the simultaneous acquisition of the navigator and the readout and also offers the advantage of using a Cartesian grid. Also demonstrated is its ability to identify fine tract splits.

**2468. High Resolution SENSE-DTI at 3 Tesla using a High Performance Gradient System**

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Detailed study of different brain structures using DTI is seriously hampered by the current resolution limits of the technique. One of the substantial limiting factors is signal-to-noise ratio (SNR) and its strong link to voxel size. In the present work it is demonstrated that for DTI based on single-excitation spin-echo EPI, parallel imaging using a high performance gradient system (80mT/m gradient coils) improves SNR efficiency as well as image quality, and therefore enables DTI with very high spatial resolution. High quality SENSE-DTI data with an in-plane resolution of 0.63 x 0.63 mm² is presented.

**2469. High Angular Resolution Diffusion Tensor Imaging with Sensitivity Encoding (SENSE) Accelerated Echo Planar Imaging (EPI)**

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In DTI data acquisition, high angular resolutions and whole brain coverage require very long scan times. EPI readout is effective in reducing the scan time, but it is prone to blurring and distortion. Recently, sensitivity encoding (SENSE) has been introduced to traverse the k-space more rapidly. Our results demonstrate the feasibility for applying SENSE to minimize the EPI acquisition duration in DTI without noticeable difference in FA and ADC values. The addition of SENSE dramatically reduces the EPI readout duration and the resultant blurring. The intrinsic SNR penalty associated with SENSE is partially offset with a shortened effective TE.

**2470. Optimization of Diffusion Tensor MR Imaging Data Acquisition Parameters for Brain Fiber Tracking using Parallel Imaging at 3T**

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The feasibility of diffusion tensor (DT)-MRI increased with the development of parallel imaging technique combined with high performance gradient coil system. However, number of reports using 3T magnet and the parallel imaging technique is still small. Typically 3-5 mm thick slice was obtained at 1.5T with multiple signal averagings. In this study, we optimized the clinical DTI scan protocol for whole brain fiber tracking at 3T using 2 mm slice thickness in 2 minutes. Excellent visualization of trigeminal nerve as well as pyramidal tract was obtained in healthy volunteers.

**2471. In Vivo Anisotropy and Diffusivity of the Optic Nerve: Pilot Study**

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1Institute of Neurology, London, UK; 2Imaging Science and Biomedical Engineering, Manchester, UK; 3Kings College London, London, UK

Diffusion tensor imaging (DTI) of the optic nerve (ON) is particularly challenging because of several problems: the small ON size, its motion and the bright signal from the fat and cerebrospinal fluid that surround it. Using ZOOM-EPI we have shown that ON DTI is feasible and gives quantitative measurements of anisotropy as well as diffusivity. In one slice of the central portion of the ON we measured mean diffusivity and fractional-anisotropy in 10 normal controls. Measurements of the DT eigenvectors also confirmed the highly directional orientation of the ON fibres.

**E-POSTERS: Diffusion: Animal Models**

**2472. Longitudinal Assessment of a Myelination Pathology in a Mouse Model by Texture Analysis of Brain Images**

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A longitudinal assessment of brain demyelination has been performed in the cuprizon mouse model over 56 days, studying four regions in sagittal slices of T2-weighted images. Assuming an organised pattern of the pixels related to the periodicity and abundance of myelin sheets, the application of a high order statistical texture analysis of the images yielded a parameter called 'horizontal grey level non uniformity'. This parameter evolved similarly to the myelin histological ultrastructure, displaying a transitory remyelination at day 41, while the average intensity (first order texture parameter) did not.
**Non-Invasive Monitoring of Niemann Pick type C Disease in Mice with Diffusion Tensor Imaging**

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Niemann-Pick Type C (NPC) disease is a disorder in the intracellular trafficking of cholesterol and results in the accumulation of unesterified cholesterol in the brain and to neuronal death. Because of the significant neurodegeneration associated with this disease, we have begun evaluating diffusion tensor imaging (DTI) as non-invasive tool to monitor the progression of NPC in a mouse model. DTI was carried out in NPC and wild-type mice and several anisotropy values were determined. Anisotropy values in NPC mice were lower than those measured in WT mice in a number of white matter structures.

**Application of the MR Diffusion Anisotropy Imaging for the Assessment of MPEP Neuroprotection Effects on the Rat Spinal Cord Injury In Vivo**

Andrzej Jasinski, Tomasz Banasik, Zenon Su, Katarzyna Majcher, P Brzegowy, Dariusz Adamek, Tomasz Skóra, Andrzej Pile, W P Węglarz

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Diffusion anisotropy imaging (DAI) of the rat spinal cord after contusion using weight-drop method was used to study the neuro-protecting effect of 2-methyl-6-(phenylethynyl)-piridine (MPEP) – an mGlu5 receptor antagonist. 18 rats were investigated, divided into 3 groups of 6 animals: a control group with laminectomy, a reference group with injury and a test group with injury and MPEP. DAI was performed at 4.7 T at 1h, 24h, 48h and 7d after the injury. DAI results confirm positive effect of MPEP on the limitation of secondary exitotoxic injury in the spinal cord.

**Treatment with a Human Antibody That Promotes Remyelination Results In Decreased Lesion Load as Detected by T2 Weighted MRI in a Viral Model of MS**

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In MS models remyelination may be triggered by the sHIgM22 antibody. TMEV-infected SJL/J mice were followed by T2 weighted imaging. The lesion loads were not different before treatment. Five weeks later they decreased by 40.6% in the treated group, and increased by 13.6% in controls (p=0.0000027). 18.75% of lesions in the controls showed retraction vs 82.8% in the treated group. We also observed prominent T2 hypointense lesions in the sHIgM22 treated animals. Their presence may be related to remyelination. The decrease in T2 hyperintense volume may be related to a “masking” effect of these hypointensities.

**Comparison of DTI-SSFSE and DTI-SSEPI Sequence for White Matter Tractography of Dog Spine**

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DTI-SSFSE was developed for spinal tractography. We compared the results of white matter tractography of dog spine, scanned by DTI-SSFSE and DTI-SSEPI. DTI-SSFSE sequence generated better spinal DTI images with much less distortion and therefore better tractography than those generated by DTI-EPI sequence, although it has lower SNR due to stimulate echo. The distortion of EPI sequence hindered its usage in spinal tractography study.

**E-POSTERS: Diffusion in Healthy and Diseased Brain**

**DWI Predicts Future Progression to Alzheimer’s Disease in People with Amnestic Mild Cognitive Impairment**

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People with amnestic mild cognitive impairment (aMCI) are at an elevated risk for developing Alzheimer's disease (AD). Hippocampal apparent diffusion coefficients (ADC) are elevated both in patients with MCI and AD. We followed 57 cognitively normal elderly, 5 of whom progressed to aMCI or AD, and 22 patients with aMCI 12 of whom progressed to AD after 40±12 months. Patients with aMCI who progressed to AD had higher hippocampal ADC at baseline than the ones who were stable. Hippocampal ADC may be useful in identifying patients with aMCI who will progress to AD in the future for preventive therapies.

**High-b-Value Diffusion-Weighted MR Imaging in Hyper-acute Stroke**

Hyon Jeong Kim, Choong Gon Choi, Jeong Hyun Lee, Deok Hee Lee, Sang Joon Kim, Dae Chul Suh, Ho Kyu Lee

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Diffusion-weighted magnetic resonance (MR) imaging has proved to be a critical tool for detection of acute cerebral infarction by allowing early confirmation of ischemic damage before it can be identified with conventional MR imaging. Recent improvement in MR gradient technology permits higher b values and greater diffusion sensitivity without prohibitive signal-to-noise degradation. The purpose of our study was to determine the validity of high-b-value (b = 2,000) DWI in hyper-acute stroke by comparing with b = 1,000 images at 1.5 tesla system.
2479. Early Prediction of the Prognosis for Motor Function after Stroke using Diffusion Tensor Imaging
Yasuhiko Osaka¹, Toshihiko Ebisu¹, Chuzo Tanaka¹, Masaki Fukunaga¹, Masahiro Umeda¹, Takashi Houri¹, Yasuo Inoue, Shoji Naruse¹, Katsuyoshi Mineura¹
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The goal of this study was to determine if the prognosis for motor function is predicted using diffusion tensor imaging (DTI) in the early stage after stroke. Thirteen patients with hemiparesis were examined. Normalized relative FA (rFA) in internal capsule, cerebral peduncle, and pons of the poor recovery group was significantly decreased at 14 days or later. Furthermore, the rFA in these regions at 14 days or later was well correlated with the final Brunnstrom stage. Our findings were consistent with the hypothesis that the prognosis for motor function after stroke is predicted using DTI at 14 days.

2480. Mean Diffusivity Correlates with Executive Function in Patients with Hypertension: A Diffusion Tensor Study
Arani Nitkunan¹, Sumeet Singhal¹, Thomas Richard Barrick¹, Michael O'Sullivan¹, Christopher Andrew Clark¹, Hugh S. Markus¹
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Hypertension is known to be associated with white matter lesions and with cognitive impairment. However, the mechanism underlying this is not known. It is hypothesized that patients with hypertension have white matter tract damage leading to disruption of cortical-subcortical and cortical-cortical connections and hence cognitive impairment. This diffusion tensor imaging study comparing patients with asymptomatic hypertension with normotensives revealed structural changes in the thalamus. The mean diffusivity obtained from the thalamus correlated with tasks of executive function. Larger studies need to be conducted to improve the power of this study.

Keiichi Ishigame¹, Hiteto Toyoshima¹, Masanobu Ibaraki⁵, Shigeaki Aoki¹, Yoshitaka Masutani¹, Atsushi Umetzu¹, Eku Shimosegawa¹, Kumiko Okane¹, Junia Moroi¹, Akifumi Sazuki¹, Osamu Abe¹, Masaaki Hori³, Toshiyuki Okubo⁴, Tsutomu Araki⁴
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We applied three-dimensional white matter tractography with diffusion-tensor MR analysis to assess the location and degree of corticospinal tract injury in patients with acute deep intracerebral hemorrhage. We assessed whether the corticospinal tract could be depicted and the apparent diffusion coefficient and found that both were related motor functional outcome of patients with deep intracerebral hemorrhage. Three-dimensional white matter tractography may be useful for evaluating corticospinal tract injury associated with acute deep intracerebral hemorrhage.

2482. A Semiquantitative Classification of Brain White Matter Pathways in Cerebral Palsy using Diffusion Tensor Imaging
Lidia M. Nagae-Poetscher¹, Alexander H. Hoon, Jr., Elaine Stashinko, Hangyi Jiang¹, Setsu Wakana¹, Michael V. Johnston, Peter van Zijl³, Susumu Mori¹
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While MR imaging clearly identifies brain abnormalities in 70-90% of children with cerebral palsy, resolution of injury in specific white matter pathways is limited. Diffusion tensor imaging (DTI) allows identification and assessment of brain white matter tracts. Using color-coded DTI maps acquired at 1.5 Tesla with Sensitivity Encoding (SENSE) technique, we established a semiquantitative classification of 25 cerebral structures in children with cerebral palsy and a group of control children. This approach can be used to refine injury classification, improve understanding of pathogenesis, and lead to improvements in treatment for children with cerebral palsy and other childhood neurological syndromes.

2483. Whole Brain Fractional Anisotropy Analysis in HIV Patients with Elastic Registration
Hongyu An¹, Yasheng Chen¹, Keith J. Smith¹, Colin Hall¹, Kevin Robertson¹, Kathy Wilber¹, Wendy Robertson¹, Lester Kwock¹, Weili Lin¹
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A method for whole brain fractional anisotropy (FA) analysis in HIV patients is presented. A bi-directional elastic registration based on FA is utilized to register the FA images of HIV patients to a normal white matter atlas generated from healthy human volunteers. This allows a direct pixel-by-pixel analysis of FA differences between the two groups and eliminates the need to predefine region-of-interest. For most of the white matter, FA is lower in the HIV patient group. The most significant FA reduction was observed in the precentral gyrus and anterior prefrontal area, corresponding to the motor and pre-motor regions.
2484. Diffusion Tensor Tractography in Unilateral Polymicrogyria with Involvement of the Precentral Gyrus

Naoto Hayashi¹, Kenji Ino¹, Yoshitaka Masutani¹, Shigeki Aoki¹, Osamu Abe¹, Tomohiko Masumoto¹, Harashi Mori¹, Kuni Ohtomo¹
¹University of Tokyo Hospital, Tokyo, Japan

Primary motor area may be relocated from the precentral gyrus to other areas in patients with cortical malformation involving the precentral gyrus. To investigate the course of corticospinal tract in unilateral polymicrogyria involving the precentral gyrus, diffusion tensor tractography was applied. We found that the course of corticospinal tract in the affected hemisphere to be deviated abnormally compared to the course of corticospinal tract in the normal contralateral hemisphere. Diffusion tensor tractography is a promising tool to investigate the course of major fiber tracts.

E-POSTERS: Tract Tracing using MEMRI

2485. MRI Tracing of Manganese Transport in the Mouse Brain After 3rd Ventricle Application

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Neuronal tract tracing has been performed with various imaging techniques. However, the structure and functional information obtainable is limited by those methods using the historical sections. We performed 3D MRI with MnCl2 injected into third ventricle of the mouse brain and traced neuronal Mn2+ distribution in vivo. The results demonstrate the useful application of this method to trace neuronal connectivity, which may provide a pertinent method for phenotyping mutant mice with abnormal neural connectivity in vivo.

E-POSTERS: Non-Neuro Diffusion

2486. Renal 3D Diffusion Tensor Imaging in a Single Breath-Hold using Single Shot 3D GRASE

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Diffusion imaging is very sensitive to body motion. Therefore, to date, abdominal diffusion measurements are performed within a single breath-hold, which limits the number of diffusion gradient directions and the slice coverage. We present a diffusion-weighted single-shot 3D GRASE sequence which acquires full renal diffusion tensor images (six directions plus b=0 image) with up to 20 slices within a single breath-hold of 18s. Mean ADC values for the medulla and the cortex were (3.8±0.9) and (4.5±0.8) •10-3 mm2/s, respectively. It is expected that rotationally invariant diffusion measurements will improve reliability and quality of renal functional measurements.

2487. Visualization of High-Resolution Myocardial Strain and Diffusion Tensor using Super-Quadric Glyphs

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A novel technique for visualizing diffusion tensors and strain tensors in canine myocardium is demonstrated. Superquadric implicit functions provide a means of creating a continuum of shapes between these four basic eigenvalue configurations: λ₁=λ₂=λ₃ (spherical), λ₁<λ₂=λ₃ (planar), λ₁>λ₂ = λ₃ (linear), and λ₁>λ₂>λ₃ (cuboid). In comparison to existing glyphs based on ellipsoids or boxes, these glyphs have the advantage of clarifying shape differences without inappropriately emphasizing the tensor orientation determined by its eigenvectors. Strain tensors in neighboring regions do not exhibit the same helical pitch indicating that diffusion and strain tensors do not remain co-axial.

2488. Peripheral Nerve Diffusion Tensor Imaging

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MR diffusion tensor imaging with fiber tracking was performed on the peripheral nervous system. 3 healthy subjects were examined on a 1.5 Tesla MR-scanner. Though inherent susceptibility to motion, field inhomogeneities and fast T2-relaxation of the diffusion imaging technique the sciatic nerve could be detected. Further investigations needs to be done to improve the SNR and to see if smaller peripheral nerves than the sciatic nerve can be detected. If so, one may in the future expect clinical indications for peripheral diffusion tensor imaging with fiber tracking.
E-POSTERS: Perfusion in Cerebrovascular Diseases

2489. Continuous Monitoring of Stroke Evolution Using Intraarterially Injected PWI in an Animal Model

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Repeated CBF studies can provide guidance to thrombolytic therapy by demonstrating the evolution of ischemic penumbra in acute stroke patients. Intraarterial PWI with small contrast boluses was performed in a swine stroke model. Reproducible CBF measurements were obtained every 15 minutes using 0.04 to 0.15 mmol/kg of gadolinium DTPA at 2 to 4 ml/s. Cortical CBF values showed no significant differences between IA and IV injections (195±11 vs 189±20). IA PWI values were predictive of infarct or recovery. Our study demonstrates the feasibility of continuous CBF monitoring with intraarterial injection, a potential advantage of performing intraarterial thrombolysis under real-time MRI guidance.

2490. Cerebral Perfusion Measurements by Dynamic Susceptibility Contrast MR and a Gaussian Relaxation Model

John J. Lee1, Joanne Markham1, Tom O. Videen1, Colin P. Derdeyn1, William J. Powers1, Joshua S. Shimony1
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Measuring cerebral perfusion by MR yields qualitative data that proves useful for the evaluation of stroke, especially with diffusion-weighted MR. We extend standard methods of MR perfusion processing using a relaxation theory that incorporates the Gaussian dynamics of underlying molecular diffusion. The results depend quadratically on the concentration of contrast agent. We applied standard methods and the Gaussian relaxation theory to MR perfusion and compared these to PET data. The relaxation model demonstrated significant and stronger association with PET than the standard model. The pursuit of quantitative MR perfusion should benefit from a Gaussian relaxation model.

2491. MR Assessment of Cerebrovascular Reserve in Patients with Symptomatic Carotid Artery Occlusion using an Acetazolamide Challenge

Iain D. Wilkinson1, Paul D. Griffiths1, Peter A. Gaines2, Treveror C. Cleveland2, Jonathan Beard2, David Capener1, Graham Venables2
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Haemodynamic stroke results from low cerebrovascular flow. This paper reports an assessment of the factors defining low-flow states at rest and following challenge with a carbonic anhydrase inhibitor. Six symptomatic patients underwent MRA plus gadolinium perfusion assessments before and after injection of acetazolamide. All had longer transit time in the symptomatic hemisphere. This asymmetry increased after acetazolamide, taken to indicate failed cerebrovascular reserve. There was close correlation between increased transit time and collateralisation around the circle of Willis, highlighting the importance of knowing the anatomy of the circle of Willis when interpreting cerebral perfusion data and cerebrovascular reserve.

2492. Pulsed Arterial Spin Labeling Perfusion MR in Neonates with Severe Congenital Heart Defects — Feasibility, Reliability and Repeatability

Jiongjiong Wang1, Daniel J. Licht1, David W. Silverstre2, Susan C. Nicolson3, Lisa M. Montenegro2, Sarah Tabbutt2, Suzanne M. Durning2, Mayadah Shabbout2, David M. Shera2, J William Gaynor2, Thomas L. Spray2, Robert R. Clancy2, Robert A. Zimmerman2, John A. Detre1
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A pulsed arterial spin labeling (PASL) technique has been used to measure the preoperative cerebral blood flow (CBF) in 25 neonates with severe congenital heart defects. A low level of CBF (18.1ml/100g/min) was observed at baseline, which was elevated under hypercapnia conditions (36.9ml/100g/min). PASL perfusion measurements were highly reproducible (4.1% repeatability) in this cohort of neonatal patients. Regression analyses indicated that the baseline CBF and its response to CO2 were associated with the hemoglobin level and mean arterial pressure. Technical and physiological issues related to the accuracy of perfusion measurements in neonates are discussed.

E-POSTERS: Metabolomics, Perfusion, and Diffusion in Cancer

2493. Localised 2D COSY of Human High-Grade Glioma Tumours

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The objective of this study was to determine whether additional metabolites were observable using a localised 2D COSY 1H-MRS sequence in human high-grade glioma tumours (n = 5). The 2D COSY sequence was implemented on to a 1.5 T MRI system and each 2D spectrum was acquired using the manufacturer’s head RF coil. In addition to diagonal resonances of lipids, NAA, creatine and choline, a cross-peak due to lactate was seen in all 2D COSY spectra. Cross-peaks due to threonine and phosphoethanolamine were observed in two of the patient spectra and assigned on the basis of phantom studies.
2494. Proton MRS of Skin Biopsies Distinguishes Melanoma from Benign Lesions
Edward Hsiao1, Roger Bourne1, Jonathan Stretch1, Richard Scolyer1, John Thompson1, Carolyn Mountford1, Cynthia Lean1
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MRS of skin biopsies offers a hitherto untested diagnostic test for melanoma. In this study, punch biopsies were taken from 27 skin lesions and normal skin for MR spectroscopy. Linear discriminant analysis (LDA) was performed on integrals of 14 contiguous regions of the proton MR spectrum of each biopsy. MR spectroscopy of skin biopsy discriminated melanoma (n=10) from benign skin lesions (n=17) with a sensitivity of 90% and specificity of 94%.

2495. Tumour Grade, Estrogen Receptor Status and Progesterone Receptor Status Determined from a Single Fine-Needle Aspiration Breast Biopsy using 1H MRS and a Statistical Classification Strategy
Sinead T. Doran1, Cynthia Lean1, Brion Dolenko2, Peter Malycha1, David Clark1, Laurence Gluch1, Uwe Himmelreich1, Ray Somorjai2, Carolyn Mountford1
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Tumour grade, estrogen receptor (ER) status and progesterone receptor (PgR) status are important for staging breast cancer and predicting patient outcomes. Determining these prognostic indicators requires preparing cell blocks, histopathology and expensive immunohistochemistry. Fine needle aspiration biopsies from primary tumours from breast cancer patients were analysed using 1H MRS. Diagnostic correlation of spectra and histopathology or immunohistochemistry using a Statistical Classification Strategy distinguished: Grade 1 and 2 tumours from Grade 3 with an accuracy of 94.7%; ER positive and ER negative tumours with an accuracy of 90.6%; PgR positive and PgR negative tumours with an accuracy of 86.7%.

2496. Magnetic Resonance Image-Guided Proteomic Analysis of Human Glioblastoma Multiforme: A Two-Dimensional Gel Electrophoresis Study
Gongyi Shi1, Yingyun Wang1, Yi-Shan Yang1, Samira Guccione1, Ron Homer1, Griff Harsh1, Scott Atlas1, Mark Bednarski1
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In this study, we investigate the correlation between gadolinium contrast-enhancement patterns on T1-weighted magnetic resonance (MR) images and spatial changes in protein expression profiles in human glioblastoma multiforme (GBM). We demonstrate that major differences in protein expression patterns within a tumor can be correlated to radiographic findings. MRI can serve as a powerful tool for characterizing different regions of tumors prior to proteomic analysis designed to identify diagnostic markers and therapeutic targets for tumors.

2497. 19F Metabolite Imaging for 5-FU Dynamics and Tissue Characterization at 9.4T
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1National Institute of Radiological Sciences, Chiba-Shi, Chiba, Japan; 2Kyushu University, Fukuoka-Shi, Fukuoka, Japan

Quantitative chemical shift imaging is the most informative method for the drug dynamics. 19F fast spin echo imaging was modified for 5-FU mouse study at 9.4T. Simultaneous 4 signal acquisition including anabolites Fucn is demonstrated near 1mM. T2 maps constructed from the same data set served for the quantification and tissue characterization. The results may lead to high field 19F-images in the clinical tumor therapy.

2498. Fertility Preservation by Ovarian Transplantation: Multiparameter Mapping of the Graft Neo-Vasculature
Tomer Israely1, Hagit Dafni1, Nava Nevo1, Michal Neeman1, Alex Tsafiri1
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Ovarian cryopreservation was suggested for rescuing oocytes from damage during anticancer treatments. The main obstacle in subsequent ovarian grafting is damage due to impaired perfusion. The aim of this study was to characterize angiogenesis after ovary xenotransplantation. Rat ovaries were transplanted on the muscle of CD1-nude mice. Damage was evident during the first days followed by vascularization. By 2-3 weeks, both blood volume and permeability were significantly elevated in the graft relative to the adjacent muscle, followed by elevation of interstitial convection and lymphatic drain. Combination of implantation on the muscle, ovariecomy and PMSG stimulation enabled retrieval of functional oocytes.

2499. Objective Quality Criteria for Fitting Dynamic Enhancement Curve in Perfusion-Permeability MRI
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Physiological parameters of tissue perfusion can be derived from dynamic MR series. However, visual is not efficient in parametric imaging to characterize and quantify the quality of fits. Quadratic error (Q) contains both model error and noise. We introduce new criteria: quadratic model error (Q'), corrected correlation coefficient (R^2) and residual information fraction (B), and a technique to estimate them. These criteria, applied to MR series of mice, with tumor model, are more efficient to detect not relevant physiological parameter images obtained with bad quality of fits.
**2500. VEGF Overexpression Alters Co-Localization Patterns of Vascular and Metabolic Parameters**

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Vascular endothelial growth factor (VEGF-A) is a potent angiogenic and permeability factor and its expression has been linked to metastasis in clinical studies. Here for the first time we have investigated the effect of VEGF overexpression on the relationship between vascular and metabolic parameters in a human prostate cancer model, using combined MRI and MRSI. VEGF overexpressing tumors exhibited patterns of co-localized vascular volume, permeability, total choline and lipid which were distinct from control tumors. These data suggest that VEGF overexpression can influence the choline and lipid metabolism of tumors.

**2501. VEGF Expression in Osteosarcoma Correlates with Vascular Permeability by Dynamic MRI**


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In summary, we examined a series of 15 osteosarcomas for the expression of VEGF and correlated this expression with model parameters for vascular permeability by DEMRI. Results from this study suggest an important role for DEMRI in assessing tumor angiogenic factor in a non-invasive manner. As such, the physiologic basis of DEMRI as a surrogate measure for tumor neovascularization in OS can be explained partly by tumor VEGF expression. The potential use of DEMRI to stratify OS patients according to angiogenic and metastatic potential of their tumors may be of clinical significance.

**2502. Characterization of Tumor Perfusion: DCE-MRI During Slow Infusion**

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Quantification of tumor perfusion is of great importance for improving tumor diagnosis and therapy management. We applied a slow infusion (“drip”) contrast-enhanced protocol and high resolution T1 weighted and T1 MRI, in order to better understand contrast enhancement mechanisms and tumor perfusion processes. We demonstrated the new approach in two tumor models: a metastatic human breast cancer animal model and invasive lung cancer model. Analysis of the images yielded the distribution of the effective GdDTPA concentration throughout the tumor at steady state, assessment of the extravascular-extracellular volume fraction as well as the identification of regions with interstitial fluid hypertension.

**2503. Fractal Parameters Derived from Analysis of DCE-MRI Data Correlates with Response to Therapy in Rectal Carcinoma**

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Fractal analysis was performed on dual-gradient echo sliding window DCE-MRI data in order to identify predictors of response to chemoradiotherapy in rectal carcinoma. Correlation analysis was applied to derived parameters, which included the box-counting dimension df, relative dispersion scaling dimension D, lattice concentration L and perimeter P. Several parameters correlated with outcome to therapy, most notably lattice concentration with percentage regression in tumour area following chemotherapy (p < 0.01, r = 0.82).

**2504. Evaluation of Surface-to-Core Perfusion in Cervical Cancer Tumors and the Role of Necrosis**

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Tumor perfusion is commonly presumed to be poorest in the central portions, where hypoperfusion and necrosis may occur. Evaluation of the degree of tumor necrosis may reveal a relationship to the overall effectiveness of the chemo and/or radiation therapy (RT). The purpose of this current study is to (1) measure the distance of each tumor pixel to the three dimensional surface of the tumor and correlate it with the signal intensity of the corresponding pixel on the perfusion imaging study, and (2) to apply the distance parameters to facilitate the localization and delineation of hypoperfusion/necrosis.

**2505. Fractal Parameters Derived from DCE-MRI Data as markers of Response to Treatment**

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The objective of this work was to show that functional morphological assessments of clinical data derived from DCE-MRI is possible using methods of fractal analysis. Methods are presented in which fractal analysis is compared with the conventional radiological criteria, RECIST. Fractal analysis was applied to sequential DCE-MRI data, from which a number of metrics were defined. The tumour under investigation showed no change according to RECIST. It was found that the fractal analysis presented here enabled the discrimination and characterisation variations in tumour functional morphology.
We present the results from a DCE-MRI study of patients in a longitudinal study of the effect of adding antiangiogenic therapy to traditional chemotherapy in the treatment of breast cancer. Focus is placed on a particular method for accounting for morphological changes in the tumor that occur over the course of treatment, and on the relationship between measurements of change in tumor volume and perfusion.

**Application of Simultaneously Acquired T1 and T2* Dynamic Perfusion Study using Gd-DTPA in Breast Tumors of the Rat**

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The purpose of this study is to test the application of simultaneously acquired T1/T2* dynamic perfusion using Gd-DTPA in breast tumors of rat and to test the differential diagnosis between benign and malignant breast tumor using permeability and corrected T2* perfusion. The result demonstrated K1 and K2 were not correlated with histological parameter. Dynamic curve pattern of AR2* was different between benign and malignant breast tumor. The method to correct AR2* using T1/T2* could differentiate between benign tumor and malignant carcinoma in rat breast tumor. Vascular permeability using Gd-DTPA could not differentiate between benign and malignant breast carcinoma.

**Detection and Localization of Prostate Carcinoma and Benign Prostatic Hyperplasia using DTI**

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In an ex vivo study of nine human prostate specimens, dramatic ADC decrease was observed in the region of prostate carcinoma (PCa). The estimated extent of carcinoma and its location, as estimated from ADC maps, correlated well with estimates from histology. The RA map delineated BPH distinctively. These results suggest diffusion MRI offers promise in the detection, localization, and size estimation of prostate cancer and BPH.

**Serial ADC Measurements in Low Grade Gliomas as a Predictor of Malignant Transformation**

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Low-grade gliomas progress to high-grade gliomas at an unpredictable time point. We performed longitudinal diffusion-weighted MR in low grade glioma patients to assess whether malignant transformation is associated with changes of the apparent diffusion coefficient (ADC). We analysed whole-tumour ADC histograms and found, in patients with malignant transformation, a significant left shift of the peak location (towards lower ADC values) and an increase in tumour fraction with ADC values below 1000x10^-6 mm^2/s. Changes in non-transformers were minor and in the opposite direction. ADC histogram analysis can differentiate between histological tumour progression and stable tumours and are superior to volume measurements.

**Diffusion-Weighted Magnetic Resonance Imaging Characterization of Anti-Tumor Activity of MLN2704 in a Bone Metastatic Cancer Model**

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Diffusion-weighted MRI was used to characterize the effects of therapeutic treatment of MLN2704 on a murine model of prostate cancer metastasis. MLN2704 is a novel drug designed to deliver the chemotherapeutic DM1 directly to prostate cancer cells via MLN591, a targeting monoclonal antibody vehicle that binds specifically to PSMA. Treatment of tumor bearing mice with MLN2704 resulted in the dramatic reduction (>90%) of tumor volume as compared to placebo-treated mice. In man, metastatic androgen-independent prostate cancer frequently manifests metastases to bone, and the application of MRI for tumor evaluation in animals represents significant translational opportunities into clinical trials.

**E-POSTERS: Intracranial MR Angiography**

**Preliminary Development of an Automated Analysis Tool for Intracranial MRA**

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We present our preliminary experience with an automated vascular analysis tool we have developed for intracranial MRA. Starting with a segmentation of the vasculature, morphological operators are used to detect bifurcations within the vasculature. These bifurcations are used to organize the segmented data into discrete vascular segments and define the boundaries for centerline computations. Centerlines are computed between bifurcation points or end points using a least squares spline routine with an iterative process to control the amount of smoothing applied. With the centerlines computed, morphological characterization of the vasculature can be done automatically. Initial results are promising.
2512. Comparing 1.5T and 3T Field Strengths in TOF MRA in Patients with Intracranial Vessel Disease

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The higher field strength of 3T over 1.5T leads to increased SNR and substantial gains in blood-to-background contrast (BBC) in TOF MRA at the higher field strength. When treading the increased SNR for higher spatial resolution, the increased BBC contrast is valuable for imaging distal intracranial vessels. We compared 1.5T TOF MRA to 3T unoptimized and to 3T optimized, in 10 patients with different intracranial vessel disease. 3T optimized TOF leads to a significant increase of the SNR, CNR and BCC compared to 1.5T, and to marked increase in vessel length visualization, leading to increased lesion detectability.

2513. Evaluation of Serial Changes Over Time in Intracranial Aneurysms

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Co-registration software is used to compare images of patients with untreated giant intracranial aneurysms to detect serial changes over time. This analysis demonstrates that changes that are difficult to evaluate by eye can be clearly delineated and quantitated. Aneurysmal growth and thrombus deposition were identified.

E-POSTERS: Spine MR Imaging

2514. Human Spinal Cord Diffusion Tensor Imaging at 3T

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We compared two gated multi-shot diffusion tensor imaging techniques: turbo spin echo and spin-echo, echo-planar imaging of the spinal cord. In the sagittal orientation, the turbo spin echo diffusion weighted images were less prone to distortion near the ends of the vertebral bodies, but showed persistent ghosting artifacts in the baseline (T2-weighted) images, precluding calculation of tensor-related quantities such as fractional anisotropy. In axial acquisition, the echo-planar images were of higher SNR, and less artifact prone than the turbo spin echo images. Fiber tracking at the present .9 x .9 x 5mm spatial resolution was possible to a certain degree.

2515. Can Diffusion Weighted MR Imaging Differentiate Spinal Infection from Malignancy?

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Purpose: To determine the ability of diffusion weighted MR (DWMR) in differentiating spinal infection from malignancy. Methods: A prospective MR diffusion study on 27 consecutive patients with suspected spinal infection or malignancy was performed. Apparent diffusion coefficients (ADC) were calculated from regions of interest. Results: ADC of tuberculosis, other infections and malignancy were significantly higher than normal bone (p=0.0022). The ADC of malignancy was significantly lower than infective lesions (p=0.001). Conclusion: DWMR is useful to differentiate spinal infection from malignancy.

2516. Differentiation between Benign and Malignant Compression Fractures by Measuring Apparent Diffusion Coefficients of Vertebral Body Bone Marrows

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The aim of this study was to measure the ADC values in benign and malignant compression fractures and thus to evaluate the effectiveness of DW-SSFSE to differentiate between them. In all forty-three patients, the ADC could be calculated. Mean ADC value (1.15±0.19 x 10^-3mm^2/sec) of benign compression fracture (n=40) were significantly higher (p<0.05) than those of (0.84±0.19) metastatic one (n=39). When an ADC smaller than 1.10 x 10^-3mm^2/sec was used for predicting malignant compression fracture, the accuracy of 78%, with 77% sensitivity and 78% specificity, was obtained. ADC measurements may be useful in differentiation between benign and malignant compression fractures.

2517. Diffusion-Weighted Imaging of the Spinal Cord using SENSE at 3T

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This study explored the feasibility of diffusion-weighted spine imaging using SENSE at 3T with a clinical spine coil. Diffusion-weighted, single-shot EPI images were acquired in the axial plane at three different resolutions. The high field provided large signal-to-noise and SENSE was used to reduce image distortions. The high resolution axial images provided excellent spinal cord boundary definition and minimized partial volume effects in diffusion coefficient mapping. Average diffusion coefficients were 0.4 ± 0.1 and 1.70 ± 0.08 x10^-3mm^2/s in-plane and through-plane, respectively. In addition, sagittal diffusion-weighted images were acquired using a multi-shot EPI technique.
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Conventionally, combing heavily T2 weighting spin echo with fat suppression MR imaging can delineate the proximal roots of spinal nerves and ganglions. Recent advances in MR gradient technology allow acquisition of high-quality diffusion-weighted images and easy application for body imaging. The purpose of this study was to determine the feasibility of high resolution diffusion-weighted MR images and 3D display in visualization of the spinal nerves and plexus. Most of the ganglions and nerves were visualized clearly on MR images. High resolution diffusion-weighted MR imaging and its 3D display can be considered as an acceptable way for imaging of spinal nerves.

E-POSTERS: fMRI: Combined Measurements

2519. Image-Guided versus Function-Guided Coil Placement for TMS of Motor Cortex: Relative Anatomical Location and Intensity of BOLD-fMRI Response
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We hypothesized that (1) TMS coil placement for motor stimulation can produce good resolution and reproducibility when guided by imaged neuroanatomy and (2) comparisons between function-guided (thumb twitch) and image-guided approaches would elucidate relationships among neuroanatomy, behavioral response and coil placement. Using a calibrated coil holder/positioner with interleaved TMS/fMRI, we conducted image- and function-guided experiments. Image-guided reproducibility and resolution were as good as that obtained under function-guidance. TMS locations producing maximal thumb motion cluster nearer sulci than crowns of gyri, the site of elicited BOLD. Varying patterns of BOLD distribution suggests transsynaptic links between initial depolarization and vascular response.

2520. Fast MR Signal Changes Associated with 3Hz Spike-and-Wave Complexes in Generalised Epilepsy
Adam Liston1, Stefan Kiebel1, Khalid Hamandi1, Afrain Salek-Haddadi1, Robert Turner1, Louis Lemieux1
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We have reanalysed EEG-fMRI BOLD data in a patient with absence seizures to reveal neuroelectric activity at a time scale of the order of 100ms.

2521. Evaluation of the Gradient Noise Effects on EEG Source Localization in a Combinatory Study of EEG and fMRI
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Combinatory studies of fMRI and EEG have been increasing due to many virtues of their combination. To use the EEG data recorded during the fMRI scan in enhancing fMRI performance, the gradient switching noise should be reduced. We have evaluated effects of the gradient switching noise on EEG source localization using a phantom that has electric current dipoles mimicking a human brain. It has been found the EEG data recorded during EPI scans can be used in EEG source localization if the gradient noise is reduced down to 15-20% of the EEG signal power.

2522. A Functional MRI Study of Motor Activation During Inhaled Oxygen Challenges
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Since the BOLD response amplitude is determined by a mismatch between CBF and CMRO2, i.e. oxygen extraction ratio (OER), it can be anticipated that variation in baseline CBF would influence amplitude of positive BOLD response. In the present study we have altered inspired O2 (FiO2) between 15 and 100% and determined CBF and BOLD in healthy volunteers during self-paced finger tapping. To our surprise, no significant changes in either BOLD response amplitude or number of activated pixels were found. Similarly, increase in CBF, as determined by an ASL method, was not affected by FiO2.

2523. Concurrent fMRI Measurements with Optical Imaging Spectroscopy and LDF Measurements
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MRI experiments were conducted in which BOLD and cbv-MRI were measured concurrently with optical imaging spectroscopy (OIS) and with LDF measurements following both activation (electrical stimulation of the whisker pad) and hypercapnic challenges. GE structural maps were collected following infusion of increasing concentration of Ami-227 contrast agent and used to estimate baseline blood volume fraction in the activated cortical regions. The OIS, volume and LDF data were used in a model of oxygen transport to tissue to estimate changes in capillary and venous saturation and input to the Yablonskiy-Haacke biophysical model to estimate the extra-vasculature component of the BOLD signal.
Multiple Breath Wash-in of Sulfur Hexafluoride: A Comparison between $^{19}$F-MRI of the Lung and Respiratory Gas Analysis

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Dynamic lung imaging using 3He-MRI is the clinically established high cost-high effort solution to lung disease screening due to the artificial hyperpolarization procedure. MRI using thermally polarized fluorinated gases is not limited by the polarisation decay. Thus fluorinated gases may be reapplied without constraints. In the study presented here both reproducibility of a $^{19}$F wash-in experiment in a porcine model was checked and the method was cross-validated by respiratory gas analysis. We found that the $^{19}$F-MRI-method is highly reproducible and signal intensities are highly correlated to expiratory gas concentrations.

E-POSTERS: fMRI Data Analysis

Image Based Physiological Noise Correction for Perfusion-Based fMRI

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Image based correction of physiological noise in fMRI has been shown to improve the statistical power of experiments using BOLD contrast. However, application of these correction techniques to perfusion-based fMRI using arterial spin labeling has been limited. We present four methods for extending image based correction schemes to perfusion fMRI. While all of the methods improve statistical power, the best performance is achieved when 1) the contributions of physiological noise to the tag and control images are weighted independently and 2) the effects of physiological fluctuations during the arterial spin labeling process are included.

Stochastic Co-Registration of Functional and Anatomical Data Improves the Spatial Resolution of fMRI

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Accurate co-registration of functional and anatomical data from individual subjects is critical for the precise mapping of function on the cortical surface using functional magnetic resonance imaging (fMRI). Because of minor head movements a different spatial sampling of functional activations is inevitably obtained from successive functional images gathered during an experiment. Here a stochastic co-registration method is described wherein low-resolution functional images are re-sampled and co-registered individually with the reference brain in high-resolution anatomical brain space. Counter intuitively, small movements significantly improve spatial mapping precision when stochastic co-registration is used, as demonstrated in both simulations and fMRI experimental results.

Spatially-Thresholded Independent Component Analysis (sthICA): Generating Voxelwise Statistical Inferences from ICA Analysis of fMRI Data

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We propose a modification of Independent Component Analysis (ICA), called spatially-thresholded ICA (sthICA), for the generation of voxelwise statistical inferences from functional MRI data. The sthICA method uses a Generalized Gaussian Mixture Model (GGMM) in order to estimate the null (noise) distribution from the spatial distribution of voxel intensities, and does not involve the a posteriori separation of timecourses into signal and confound subspaces. Computer simulations show the method to exhibit minimal bias, comparable sensitivity to standard General Linear Model (GLM) approaches, and robustness to temporal autocorrelations.

Mutual Information Rate as an Objective Criterion for Comparison of fMRI Experimental Designs

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By considering the fMRI experiment as a communication system, various concepts and results from Information Theory can be applied. Specifically, we propose mutual information rate (MIR) as an objective criteria for comparing fMRI experimental designs. MIR can be used to threshold functional data sets. We show that maximum MIR is achieved at intermediate block length, since MIR is limited by channel capacity for small block lengths and by the rate information is being transmitted by the source for long block lengths. The corresponding p-values can be calculated without making noise distributional assumptions.
2529. Improving Power of Permutation Test Using Unbiased Maximal Null Distribution for fMRI Data Analysis

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With minimal assumptions and better statistical power compared to the parametric tests, permutation tests have been applied for neuroimaging data of different imaging modalities, such as PET and fMRI. To perform permutation tests on neuroimaging data, an empirical maximal null distribution has to be found, which should be free from any activated voxels. A novel approach of constructing the null distribution based on the data from the baseline periods is proposed. It provides higher statistical power while avoiding the high computational costs associated with the common iterative approach.

2530. Sequential Cross Correlation: A Robust Technique to Detect Brain Activation in fMRI

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Sequential test is generally designed to detect presence of a signal at earlier stage than fixed length test when data arrives sequentially. One often overlooked feature of sequential test is that it may detect signal more robustly in many cases. We present a novel method, sequential cross correlation (SCC), to detect brain activation in fMRI. SCC calculates cross correlation coefficients between a reference waveform and time course as more data arrive. SCC tracks and extracts intrinsic structure of the data and as such can improve brain activation detection. SCC can be applied both in real time and off-line processing.

2531. Evaluation of Distribution of Cross-Correlation Coefficients of Spontaneous Low Frequency in Alzheimer’s Disease Patients

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It has been shown that compared with normal subjects, Alzheimer’s disease (AD) patients have a significantly lower COSLOF index, which is the mean of the cross-correlation COefficients between pairs of Spontaneous LOw Frequency components of voxel time courses in hippocampus. In this study, the distribution of these cross-correlation coefficients was evaluated. AD patients have more strong negative correlation (33%) and less strong positive correlation (43%) than controls (11% and 67% respectively), which indicates that the low frequency components of AD patients are significantly less synchronized among voxels than controls.

2532. Modified Bootstrap Resampling Technique Considering Temporal Correlation in fMRI

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Traditionally, TestRetest methods have been used to determine reliability of task activated parameters. Recently, resampling techniques like jackknife and bootstrap have been used in lieu of test retest to determine the confidence intervals of fMRI parameters. Resampling techniques assume that there is no temporal correlation in the timeseries data. However, this is not necessarily true in fMRI, where temporal correlation can be due to physiological perturbations like the cardiac pulsations, respiration and CSF pulsations. In this study, the bootstrap resampling technique was modified to consider temporal correlation in fMRI signal and to obtain confidence interval of various fMRI parameters.

2533. Assumption Free Analysis of fMRI Data Sets

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Statistical tests currently used in fMRI are subject to a number of assumptions including: i) errors are independent ii) the noise has Gaussian distribution; iii) the distribution of the noise is homogenous throughout the brain; iv) the statistical model utilized is adequate to account for task-induced signal changes. Violations of any of these assumptions will lead to unreliable estimation of significance levels. In this study, we have developed a novel method for detecting and estimating task-induced signal changes without making assumptions about the nature of the measured response under the null hypothesis.

2534. Time-Frequency Analysis of fMRI Signal Response

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Most fMRI data analysis methods can be classified into 2 types: time-domain and frequency-domain methods. Time-domain methods use signal intensities to differentiate between activation and control states, any information regarding the periodicity is typically not present. Frequency-based methods although provide information regarding periodicities present in the data sets including task/stimulus frequencies and other physiological parameters including respiration frequency, etc. In this study, Time-Frequency Analysis of fMRI signals is explored. Time-frequency analysis allows representation of signals through its energy content on a 2 dimensional graph with one axis representing time and the other representing frequencies present at any given time.
E-POSTERS: fMRI Applications

2535. Quantifying the Effect of Posture on Cerebral Vascular Mechanical Compliance using Cerebral Blood Flow Measurements: Possible Implications for fMRI BOLD Response

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The capacitance of the cerebral vascular compartment to accommodate increase in blood volume is determined by the mechanical compliance state of cerebral vasculature. Compared with the upright posture, in the supine position more blood resides in the brain vasculature and therefore the overall cerebral vascular compliance is reduced. A method to measure cerebral vascular compliance from the dynamic relationship between arterial inflow and venous outflow was validated in healthy subjects scanned in upright and supine postures. Simple motor activation studies show connection between reduced fMRI BOLD response and vascular compliance is shown.

2536. Calibration of fMRI BOLD Signal: A New Approach

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In the context of quantitative fMRI, baseline deoxyhemoglobin (dHb) content or its equivalent quantity needs to be evaluated in order to calibrate stimulation-induced BOLD signal. This quantity has been indirectly estimated by use of physiologic perturbation such as respiratory CO2 challenge. Using a direct quantification of dHb-induced R2', we propose a new approach for calibrating BOLD signal.

2537. fMRI with 2-Dimensional and 3-Dimensional Visual Stimuli

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An fMRI with three-dimensional visual stimulation by anaglyph is investigated. Compared to conventional two dimensional visual stimulation, activated regions of the brain with three dimensional stimulations appear larger by more than 18%, which is probably due to more complicated processing involved in three dimensional perception.

2538. Correlations in fMRI of the Amygdalae: Motion or Emotion?

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In an fMRI study of schizophrenics and controls using emotional faces as stimuli, we observed stimulus-correlated head motion. In a separate study reported here, we establish that this motion alone, either generated by subjects themselves or via submillimetre displacements of the subject table (with no stimulus) gives rise to highly significant focal correlations in the amygdala and in some cases in the anterior cingulate gyrus. These seem likely to account for at least some fraction of the correlations reported in the many published fMRI studies of the amygdala.

2539. "Functional Unit" of BOLD and CBV fMRI in Rat Whisker Barrel Cortex at 3T

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The spatial precision of BOLD and CBV fMRI was investigated in rat whisker barrel cortex at laminar spatial resolution at 3T. The data support the hypothesis that venous unit limits spatial precision in T2*-weighted BOLD fMRI while the spatial precision of CBV fMRI is limited by microvessel densities, breaking venous unit limitations.

2540. Limits on Activation Induced Temperature Related Frequency Changes in Primary Visual Cortex

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Stimulus correlated frequency changes of water attributed to temperature changes have previously been reported. Here we report a study of simultaneous measurement of frequency changes in water, NAA, choline, and creatine using partially water suppressed magnetic resonance spectroscopy. Because temperature induced frequency shifts are much smaller for the other metabolites than for water, they can serve as a control for nonthermal frequency changes. Our results indicate that temperature changes are not a dominant cause of frequency changes during activation studies.
**2541. A Novel Technique for Spinal fMRI with Large Volume Three-Dimensional Coverage of the Spinal Cord**

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Functional magnetic resonance imaging of the spinal cord requires slices oriented transverse to the spinal cord or will suffer severely degrading partial-volume effects. Here we demonstrate a modified spinal fMRI technique based on very thin contiguous sagittal slices. The slices are reformatted into axial slices and smoothing is applied across consistent anatomy in the rostral-caudal dimension in order to attain a sufficiently high SNR. A high degree of sensitivity can thus be maintained with greater coverage of the spinal cord, at the expense of an acceptable loss of resolution in the right-left direction across the cord.

**2542. Rest Conditions in fMRI: Exploring the Differences**

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In this study we explored differences in brain activation between three probable rest conditions used in fMRI experiments: 1) when the eyes are open, 2) when the eyes are closed by the subject and 3) when the eyes are kept open but covered externally. Marx et al. (Neuroimage 2003:19: 924-933) showed that there are considerable and consistent different patterns of brain activation between an open-eyes and a closed-eyes condition that are both often used as rest conditions in a fMRI experiment. We explore the possibility of another rest condition in which the eyes are kept open but are covered externally.

**2543. Functional Magnetic Resonance Imaging Based on SEEP Contrast: Reproducibility, Hemodynamic Response Function, and Anatomical Specificity**

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We have previously demonstrated that functional magnetic resonance imaging can be carried out using a non-BOLD contrast mechanism (SEEP) that is based on proton-density changes. Here we carry out repeated studies with BOLD and SEEP contrast in healthy subjects to identify the specific anatomical locations of activity identified with SEEP contrast, and to investigate the reproducibility across repeated experiments. A high degree of reproducibility is demonstrated in 8 healthy subjects with SEEP contrast, showing activity primarily in gray matter. The signal intensity response to a stimulus is also characterized and is observed to be distinct from the BOLD response.

**E-POSTERS: Clinical Applications of fMRI**

**2544. Tinnitus-Related Cortical Regions Evaluated by fMRI**

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Chronic subjective tinnitus is defined as an individual sound sensation in the absence of a real physical sound stimulus. In 6 tinnitus patients and 6 normal hearing controls pure tones at 3000 Hz ± 2% were presented by sound proven headphones above MR noise level. An fMRI block-design was used with blocks of three different frequencies and silence pseudorandomly distributed. Data were analysed using SPM99. The contrast all tones minus silence showed primary auditory cortex at high significance levels in all individuals (p < 0.001 corrected for multiple comparisons). Four of the 6 tinnitus patients showed activation in prefrontal areas.

**2545. fMRI in Hearing Impaired Children Under Sedation**

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fMRI has been performed in severe to profoundly hearing impaired children ranging in age from 1 month to 16 years of age using two auditory stimulation paradigms. Patients under approximately 2 years of age are sedated with chloral hydrate while children between 2-5 years are sedated with sodium pentobarbitol. We demonstrate that BOLD activation can be detected at 1.5 T in children with hearing impairments under sedation. In very young subjects, Talairach composite mapping performs poorly.

**2546. Basal Ganglia Activation in Parkinson's Patients During a Motor Switching Task**

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The present study compares basal ganglia (BG) functional activation in Parkinson’s patients with that of age-matched controls using fMRI in conjunction with a motor activation paradigm known to elicit BG activation in healthy controls. The paradigm is composed of 14 alternating epochs of rest and unilateral movement. The movement consists of finger-tapping alternating with toe-wiggling Participants included 6 mildly affected Parkinson’s patients, off medication for ~12 hours, and 7 healthy controls. Clear differences in basal ganglia activation were observed between the two subject groups.
Stroke results in interrupted microcirculation in the infarct area and reduced perfusion in the surrounding areas. fMRI in a rat stroke model was performed to test the hypothesis that functional signal magnitude and activation area will be modulated by stroke. A challenge is that severe susceptibility artifacts from surgery essentially preclude the use of regular gradient-recalled EPI. We report here the strategies to deal with this problem. Results suggest that interleaved asymmetric spin echo EPI is a practical way to minimize susceptibility-induced signal dropout, and that fMRI employing iron oxide contrast agent is an effective way to improve functional sensitivity.

Subject-Specific HRF in fMRI Data Analysis for Brain Tumor and Leukemia Survivors

This study compared the canonical HRF and a subject-specific HRF in data analysis of an fMRI attention study in pediatric cancer survivors, a population at risk for cerebral vascular changes caused by therapy. BOLD signal change to a 2-sec visual stimulation was obtained as the subject-HRF. For the attention task, ROI activation was detected only with the canonical HRF, or only with the subject HRF, or both for different subjects. These results suggest that to use the canonical-HRF is generally effective. However, further investigation is needed to optimize data analysis with the subject-specific HRF in fMRI studies of clinical populations.

The Effect of Morphine on Footshock-Induced Brain Activity: A Preliminary fMRI Study

This preliminary study explored the effect of morphine on footshock-induced brain activity. When footshock stimulations were applied to the left hind paw, significant BOLD signal changes were observed in both the primary somatosensory cortex and anterior cingulated cortex. After morphine administration, both the activities were reduced and would be recovered 3 hours later. These results indicate that morphine could inhibit brain activities in these cortices, which may be related to its analgesic effect.

Comparisons Between Effective and Functional Connectivity in fMRI

Functional MRI (fMRI) can be used to determine activation in multiple brain regions and explain causal relationships or connectivity between neural systems. Effective connectivity, which is typically determined while a subject performs a task, and functional connectivity, which is assessed during resting scans, are two techniques used to evaluate brain networks. Three subjects were studied with both methods to explore the relationship between cortical areas activated during a simple motor task. This preliminary data suggests that although connectivity indices are derived from different image sets and analyses, there exists a relationship between these two measurements.

Real-Time Prediction of Brain States Using fMRI

We demonstrate real-time predictive modeling of fMRI using support vector machine (SVM) classifiers. Distinguishing characteristics of this work are that i) we are using multi-slice data rather than regions of interest, ii) feature selection relies only on threshold-based brain masking, iii) classifier output is related to predicted brain state rather than detected activation and is obtained at each individual image time point, and, iv) the computational burden of training and testing SVM is not prohibitive for multi-slice studies. In a single subject, we illustrate prediction performance with and without feedback.

Online Model-Free Detection of fMRI Signals: Application to Task Activation and Resting State Functional Connectivity

In this work, we apply an online clustering algorithm to detect both task-related activation and low frequency resting state functional connectivity in real time. This allows both the online model-free detection of activation, and expands connectivity analysis to allow online detection of “resting state” brain networks.
Evaluation of Effective Connectivity in the Visual System using fMRI
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Because the human visual system is organized in a parallel and hierarchical fashion, it is ideal for evaluating connectivity models with fMRI. We explored the connectivity from primary visual cortex (V1) to dorsal V2 (dV2) and dV2 to MT, a cortical area known to contain neurons sensitive to motion, using a path analysis model. Using time course data acquired during fMRI and structural equation modeling, effective connectivity was shown to exist between areas V1, dV2 and MT in the visual cortex.

Movement Trajectory is a Determinant of Use-Dependent Motor Cortical Plasticity
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What aspect of movement is critical to induce neural plasticity in the primary motor area (M1)? Within the M1, two major neuron groups are distinguishable; they are active for movement trajectory and muscle contraction, respectively. By using functional magnetic resonance imaging (fMRI), we discovered that movement trajectory in extrinsic space is potential determinant of motor cortical plasticity. The results contribute to develop new approaches to rehabilitate motor dysfunction in brain-damaged patients.

E-POSTERS: Cardiovascular MR

Improved Motion Compensation in Coronary MRA
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The main obstacle for reliable visualization of the major coronary arteries remains respiratory and cardiac motion. Navigator techniques and imaging during the mid-diastolic rest period have helped minimizing these artifacts. Yet, ~20% of coronary MRAs are of non-diagnostic image quality. We hypothesize that heart rate variability is one of the remaining issues in coronary MRA and negatively influences image quality. Analogous to navigator gating, we have introduced an adaptive RR-interval acceptance window and combined this method with navigator gated coronary MRA. The results show that correction for heart rate variability significantly improves image quality in coronary MRA.

Quantitative and Qualitative Comparison of 3D T2-prep TFE, Spiral and SSFP Coronary MRA
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Recently several new coronary MRA pulse sequences have become available (e.g. SSFP, spiral), but comparative studies are lacking. In the current study 3 different coronary MRA sequences at several different spatial resolutions were compared in 20 healthy volunteers. SSFP coronary MRA with 0.84x0.84x3mm resolution allowed for the longest coronary artery coverage. Distal coronary arteries (LAD: >4cm; LCX: >3cm; RCA: >5cm) were visualized in 18/20 subjects (90%) versus <80% for all other sequences.

Time-Resolved Whole-Heart Coronary MRA using a Very Small Iron Oxide Blood-Pool Contrast Medium
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A coronary MR angiographic method was developed to image the entire coronary system with a single 3D data set in a time-resolved fashion using VSOP-C184, a long-circulating blood pool contrast agent. Our approach was to make full use of the T1-shortening effect of the contrast medium by repetitive excitation during the whole cardiac cycle in near steady-state. Prospective navigator corrected gradient echo sequences were implemented. We demonstrate the feasibility of this approach to acquire 4D angiograms with high spatial and temporal resolution in pigs.

Automated Rectilinear Self-Gated Cardiac Cine Imaging
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So-called “wireless” or “self-gating” techniques has been described using either interleaved central k-space lines, or projection reconstruction to obtain MR signals synchronous with the cardiac cycle. The interleaved, central line method results in a doubling of the acquisition time, while radial streak artifacts are encountered with the projection reconstruction method. In this work, a new self-gating technique is presented to overcome these limitations. This technique was compared to ECG and pulse-oximetry based gating in 10 healthy patients. Since high quality images were obtained in all volunteers and one patient, this technique could become an alternative to ECG or pulse-oximetry gating.
2559. **3D Myocardial Tagging with Joint ECG Triggering and Respiratory Gating**  
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Spatial modulation of magnetization (SPAMM) is a well-established MRI technique for assessing 2D intramyocardial function. Some researchers have combined multiple short-axis and long-axis views to reconstruct 3D strain models that may be more consistent with the 3D fiber architecture of the heart. These multi-slice imaging techniques with sequential breath holding are prone to several problems including image misregistration and relatively thick slices that are sensitive to through-plane motion. The purpose of this study was to develop a fast 3D tagging sequence with joint electrocardiogram (ECG) triggering and respiratory gating that permits free breathing during scanning.

2560. **Echo-Planar 3-Dimensional Cine 3-Directional Flow Imaging of the Entire Heart**  
Peter D. Gatehouse\(^1\), Pauline YH Ng\(^2\), Bernard S. Carmo\(^3\), Guang-Zhong Yang\(^2\), David N. Firmin\(^1\)  
\(^1\)Royal Brompton Hospital, London, UK; \(^2\)Imperial College, London, UK; \(^3\)University of Southampton, Southampton, UK

A 3D-EPI method adapted for cardiac flow is evaluated for volume 3-directional cine ("7D") flow imaging of the entire heart and great vessels, aiming to improve the long scan duration and limited spatial and temporal resolution of spoiled-gradient-echo methods, using respiratory navigator controlled acquisition for improved image quality.

2561. **High Resolution Myocardial Tagging**  
Daniel A. Herzka\(^1\), Daniel B. Ennis\(^1\), J Andrew Derbyshire\(^2\), Peter Kellman\(^2\), Elliot R. McVeigh\(^2\)  
\(^1\)Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; \(^2\)National Institutes of Health, Bethesda, Maryland, USA

Myocardial tagging was used to quantify the wall motion of the heart with high temporal and spatial resolutions. The combination of a parallel imaging technique (TSENSE) with a high efficiency SSFP sequence allowed for the acquisition of 0.9x2.0 mm spatial resolution and ~10ms temporal resolutions (~100 frames for a 60BPM heart rate). The results of the wall motion analysis in the form of circumferential shortening are presented. The high temporal resolution allowed differences in the onset of relaxation at different regions of the heart to be detected.

2562. **In Vivo Magnetic Resonance Microscopic Imaging Reveals Neonatal Cardiomyopathy in a Mouse Model with Hey2 Gene-Knockout**  
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Aim of this study was to use the potential of non-invasive MR microscopic imaging for very early cardiac phenotype characterization in neonatal mice with Hey2 gene knockout. We studied Hey2\(-/-\) mice (n=9) at a mean age of 9 days and a mean body weight of 6.2 g by in vivo MR microscopic imaging in comparison with age and weight matched heterozygous littermates (control, n=9). MRI revealed marked dilatation of the LV with an increase in both end-diastolic and end-systolic volume (p<0.05 each). Ejection fraction was significantly reduced in Hey2\(-/-\) (p<0.01), indicating left ventricular dysfunction.

2563. **Dynamic MRI Contrast-Enhancement Time Course Measurements of the Myocardium: Results from Patients with Chronic Myocardial Infarcts**  
James William Goldfarb\(^1\), Sunil T. Mathew\(^1\), Nathaniel Reichek\(^1\)  
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We sought to develop and show the feasibility of a method capable of measuring contrast agent concentrations in the left ventricular blood pool, irreversibly injured and normal myocardium during an hour time period. After a delay of approximately ten minutes, gadolinium concentrations continued to reduce in the blood and viable myocardium creating increased image contrast with infarcted myocardium. Data suggests that improved contrast between necrotic tissue and the LV blood pool is achieved at imaging times after 30 minutes.

2564. **Myocardial Viability Assessment after Primary Angioplasty in Patients with Acute Myocardial Infarction: Comparison of Contrast-Enhanced MR Imaging with Myocardial Contrast Echocardiography**  
Robert J. van Geuns\(^1\), Elena Biagini\(^1\), Timo Baks\(^1\), Folker ten Cate\(^1\), Pim J. de Feyter\(^1\), Piotr A. Wielopolski\(^1\)  
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The assessment of reversible myocardial dysfunction after primary coronary intervention (PCI) is important for clinical decision-making. The aim of this study was to compare the merits of myocardial contrast echocardiography (MCE) and contrast enhanced magnetic resonance (MR) imaging to predict functional recovery after PCI. Identification of potential reversible dysfunctional myocardium can be determined both by MCE and MR imaging after AMI and PCI, although MR has a better specificity for the identification of reversible myocardial dysfunction (stunned myocardium).
Non-Invasive Early Detection of Acute Cardiac Allograft Rejection by MRI in Rodent Model
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The goal of this study is to investigate parameters that can detect early cardiac allograft rejection non-invasively with MRI because the current gold standard for diagnosing rejection, biopsy, is invasive and prone to sampling errors. We developed a novel heterotopic abdominal working heart and lung transplantation model in rats. Our data suggest that diastolic dysfunction precedes systolic functional loss. At the earlier stages of rejection, the relative time span of the isovolumic relaxation, regional wall motion, and tagging are sensitive for detecting early rejection, which can potentially be used for non-invasive diagnosis for early cardiac allograft rejection.

Cardiac CINE Imaging with “Dixon” Water-Fat Separation and Steady-State Free Precession
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This work describes the combination of steady-state free precession (SSFP) with a “Dixon” water-fat separation method to achieve reliable fat suppression for cardiac SSFP CINE imaging. An iterative method was used to decompose multi-coil SSFP images acquired at short TE increments into water/fat images. All images acquired in 3 volunteers and 13 patients demonstrated uniform water-fat separation with high SNR and increased conspicuity of normal anatomy and pathology. SNR measurements matched theory, and at 1.5T, a TE increment of 0.9ms was a good compromise between SNR performance and maintaining TR of 5ms or less, necessary to reduce banding artifacts.

Cardiac Imaging in the Mouse at 7T Using Projection Reconstruction for Improved Suppression of Motion Artifacts
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Cardiac magnetic resonance imaging (MRI) in the mouse was performed at 7 T using a projection reconstruction (PR) sequence and compared to a conventional gradient echo technique. PR exhibited markedly superior tolerance to cardiac and breathing motion during both ungated scout localization scans and cardiac-gated cine imaging. Insensitivity to motion becomes increasingly important at higher fields where motion artifact energy increases and significantly degrades image quality.

A Comprehensive MRI Protocol for the Assessment of Pulmonary Hypertension
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Assessment of patients with pulmonary hypertension involves a number of imaging modalities to identify those patients with treatable chronic thromboembolic pulmonary hypertension (CTEPH), assess right ventricular performance and monitor the effects of treatment. An MRI protocol incorporating measurement of right ventricular function, time-resolved lung perfusion imaging and contrast enhanced MRA of the pulmonary vasculature has the potential to replace more invasive tests and also reduce the number of tests required in the evaluation of this patient group. We retrospectively reviewed MRI studies of 16 patients with pulmonary hypertension to evaluate this MRI protocol.

Understanding Flow Artifacts and Localized Frequency Determination in Cardiac SSFP Imaging
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Balanced steady state free precession (SSFP) imaging has become the method of choice for the assessment of cardiac function at 1.5T. Recently it has been reported that frequency offsets due to either wrong resonance frequency determination or field inhomogeneity cause flow related artifacts in SSFP imaging. In this work it is shown in simulations and in in-vivo measurements that severe artifacts along the phase-encode direction emerge at locations close to dark band artifacts if there is through-plane flow of variable velocity. Using localized shimming and F0 determination, flow-related artifacts are efficiently reduced facilitating artifact-free cine SSFP imaging even at 3.0T.

Image Quality Improvements in Whole Body MRA of the Aorta by Employing Accelerated, Non-Contrast Enhanced, Cardiac Gated 3D SSFP
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This study examines the clinical feasibility of cardiac gated, breath-hold MR angiography of the aorta using a non-contrast enhanced, flow independent 3D SSFP technique. For this purpose an accelerated 3D FIESTA technique was implemented. Sensitivity encoded parallel imaging was applied to overcome scan time constraints. Motion artefacts are substantially reduced via cardiac gating without exceeding scan time requirements for breath-hold acquisitions. The results indicate that 3D FIESTA may provide benefits for clinical, non-contrast enhanced, whole body aortic MRA applications.
2571. Non-Contrast-Enhanced MRDSA using Continuous Acquisitions of ECG-Triggered 2D half-Fourier FSE with Partial Flow-Compensation and Parallel Imaging for Assessment of Cerebrovascular Hemodynamics
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The novel non-contrast-enhanced MRDSA technique, continuous acquisitions of a single slice with multiple phases, is evaluated in patients with 10 intracranial diseases. Multiple cardiac phase images at a 5-msec interval were obtained using ECG-gated 2D half-Fourier FSE with partial flow-compensation and parallel imaging. Dynamic subtraction images between a diastolic triggered image and following systolic images, in which flow void area due to pulsatile flow transmit within arteries, provided flow information like DSA. In patients with arteriovenous malformation (AVM), meningioma, and cerebrovascular occlusive diseases, natural dynamic flow of cerebral vessels is observed without use of any contrast agent.

2572. Evaluation of a New Hybrid Technique with Sagittally Acquired Images of the Calf: Elimination of Venous Contamination in 3D-CE Peripheral MRA Examination.
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Parallel imaging, optimizing 3D volume acquisition and automated moving- table have facilitated the development of magnetic resonance angiographic (MRA) techniques. The lower cost, lack of invasiveness and its superb results in the evaluation of the lower extremity vessels make the three dimensional contrast enhanced (3D-CE) peripheral MRA an attractive alternative to conventional angiography in the evaluation of peripheral vasculature. The aim of this study is to introduce a new hybrid 3D-CE peripheral MRA that will totally eliminate venous contamination and provides better demonstration of the calf and plantar vessels. This provides more accurate anatomic information for precise surgical planning.

2573. Improvements of 3DTOF MRA at 3.0T
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3DTOF MRA at 3.0T has many advantages over 1.5T. However, the increase in SAR especially with magnetization transfer (MT) is a potential drawback. This problem can be addressed by applying MT pulses only when acquiring the center of ky-kz space. Another potential drawback is increased pulsatile flow artifact. Although the elliptical centric (EC) order can reduce that artifact, it also concentrates the acquisition of central k-space data in a short time interval which increases the short-term average SAR when MT is used. This work introduces a rearranged EC view order that can simultaneously reduce flow artifacts and SAR restrictions.

2574. Initial Clinical Experience with High Resolution 4D Magnetic Resonance Angiography utilizing VIPR-ME
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Time resolved images can provide information about the physiology of various vascular structures, which may be important for patient management, but these methods generally sacrifice spatial resolution to obtain the temporal information. We present a technique using 4D Vastly-Undersampled Isotropic Projection Reconstruction (VIPR) to acquire large volume high-resolution time resolved MRA images in a series of patients. VIPR-ME provided high quality 4D image data sets in all cases. 4D MRA utilizing VIPR-ME provided clinically useful, isotropic, time-resolved images of multiple vascular structures during a single breath hold and contrast injection.

2575. Evaluation of 3D Fast SPGR and TRICKS for Distal Extremity CE-MRA
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Current techniques for distal extremity CE-MRA such as 3D Fast SPGR, lack high spatial and temporal resolution which can lead to misdiagnosis. TRICKS (time-resolved imaging of contrast kinetics) is a time-resolved technique in which a high resolution mask is initially acquired, followed by a series of temporally resolved volumes in which peripheral views of k-space are sampled less frequently and shared between frames. It is the goal of this study to evaluate the performance of TRICKS for distal extremity vascular disease and compare it to conventional 3D CE MRA techniques. Our initial experience and results will be presented.
MR Angiography with high temporal resolution is increasingly recognized to be important for peripheral vascular disease, particularly in the calf where differential flow rates, early venous filling, and retrograde filling of arteries represent significant features. Spiral 3D Gd MRA samples central k-space data with every TR, thereby allowing high temporal resolution MRA using sliding window reconstruction. These data in 15 patients using both spiral and conventional 3D MRA demonstrate that compared to 45ml Gd bolus chase MRA, spiral 3D MRA with 6ml Gd shows better depiction of pure arterial phase, demonstration of differential flow and comparable branch order visualization.

The aim of this study was to combine high field strength, parallel imaging technique and segmented k-space velocity mapping for the assessment of flow in the coronary sinus. Flow was measured quantitatively in phase images in vitro and in vivo. Retrospectively triggered segmented GRE velocity mapping sequences were used on a Philips Gyroscan Intera 3.0 T system and SENSE parallel imaging (R=2) was applied. Good flow linearity was obtained in vitro. In vivo, average flow (coronary sinus) was 0.205 ± 0.025 ml/min and a realistic value of average coronary sinus flow divided by wall mass (1.06 ml/min*g) was obtained.

A new interpretation is presented of phase contrast MRI obtained sequentially throughout the cardiac cycle using a CINE acquisition. The resulting data are shown to consist of high and low temporal frequency components whose ratio is proportional to flow velocity. The standard reconstruction approach is then shown to be equivalent to applying specific high and low pass filters to extract these two components. By generalizing these filters, new reconstruction techniques are investigated and a specific application in applying the UNFOLD technique for rapid imaging is developed.

The purpose of this current study was to develop a new 3D CE-MRA technique for selective visualisation of the proximal and distal upper-extremity arterial tree, distal superficial veins and proximal central veins in the preoperative work-up prior to AVF placement for hemodialysis access. It is shown in 15 patients that 3D CE-MRA can provide high-quality diagnostic images of all upper extremity arteries and veins of relevance for the creation of hemodialysis access in a single 40 minute exam.

Purpose: Pre-operative imaging of the lower spinal cord supplying arteries: anterior radicular arteries (ARAs) and the anterior spinal artery (ASA) using contrast-enhanced (CE) MRA. Methods: In 25 thoraco-abdominal aorta aneurysm (TAAA) patients, referred for operative treatment of an aortic aneurysm, first-pass CE-MRA images were acquired and analysed. Results: In all patients the ASA and at least one ARA were found. Conclusion: CE-MRA is capable to visualise the small feeding arteries of the spinal cord and could therefore be of value in TAAA surgery.

Purpose: To assess feasibility and accuracy of semi-automated quantitative analysis for detection of aortoiliac stenoses from 3D CE-MR-angiograms. Methods: Twenty-five patients with peripheral arterial disease underwent CE-MRA followed by IA-DSA. One observer independently evaluated CE-MR angiograms for stenoses in aortoiliac arteries using semi-automated quantification software. One other observer manually evaluated CE-MRA. Results were compared with IA-DSA and intra-arterial pressure gradient measurements. Results: Sensitivity and specificity of semi-automated analysis were 92 %, 83 %, for manual evaluation of CE-MRA these figures were 87% and 94%. Conclusion: Semi-automated computer analysis for detecting stenoses on CE-MRA is feasible and accurate for aortoiliac vessels.
2582. **Detection of Small Arteries Feeding the Spinal Cord: 0.5M Gd-DTPA versus 1.0M Gadobutrol CE-MRA**

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Purpose: To compare 0.5M Gd-DTPA with 1.0M gadobutrol for CE-MRA of feeding spinal arteries. Methods: Patients with thoracoabdominal aorta aneurysm (TAAA) underwent CE-MRA of feeding spinal arteries using 0.3mmol/kg of both agents. Image quality was quantified in terms of CNR and images were evaluated by two independent observers. Results: There was no significant difference in CNR nor subjective image quality between agents. Conclusion: 1.0M gadobutrol does not improve image quality compared to 0.5M Gd-DTPA for spinal CE-MRA.

2583. WITHDRAWN

2584. **High Resolution Magnetic Resonance Imaging Demonstrates Impaired Brachial Artery Reactivity as Well as Reduced Aortic and Carotid Compliance in Young Smokers**

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Aim of this study was to test the hypothesis that smoking not only induces peripheral endothelial dysfunction but also alters function and flow dynamics of the great arteries. 20 healthy young volunteers (mean age 30±2 y; 12 non-smokers (NS), 8 smokers (S): average daily cigarette consumption 9.4±2.6 /day, cumulative nicotine consumption 8.4±3.1 pack-years) were studied. As expected, smokers showed a significant reduction in FMD (p=0.03), indicating impairment of endothelium-dependant relaxation. The reduced FMD in smokers was accompanied by a marked decrease in vascular compliance in the common carotid arteries (p<0.04) and at various sites of the aorta.

2585. **Cardiac Output Measurement with Ungated Spiral Phase-Contrast and Triggered Real-Time SSFP Imaging**

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Cardiac output (CO) is clinically important in the assessment of patients. However, current CO measurements have proven to be elusive because of the need for cardiac-synchronization and long scan-times. We propose an ungated spiral phase-contrast (USPC) as a fast non-cardiac-synchronized method for measuring CO. USPC is shown to quickly measure accurate volume flow rates within few seconds even in the presence of strong pulsatility. Flow phantom experiments were performed, and CO of normal volunteers were measured with USPC and compared to a stroke volume calculation with triggered real-time SSFP. The results show good agreement between the two methods.

2586. **Time-Resolved 3D Velocity Mapping in the Thoracic Aorta: Three-Directional Blood Flow Patterns in Healthy Volunteers and Patients**

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An analysis of thoracic aortic blood flow in normal subjects and patients with aortic pathology is presented. 3D phase contrast MRI was employed to obtain a volumetric time resolved three-component velocity acquisition of the entire thoracic aorta. Blood flow visualization tools were applied in a study with 10 normal volunteers and demonstrated right-handed helical out flow, late systolic retrograde flow, and accelerated passage through the aortic valve plane. The effects of common pathologies in the thoracic aorta on spatial and temporal blood flow patterns were illustrated in clinical cases including ascending aortic aneurysms, aortic regurgitation, and aortic dissection.

2587. **T1 Measurement of Flowing Blood on Inversion Recovery GEPI**

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A novel pulse sequence for the measurement of T1 of flowing blood has been developed. This pulse sequence employs a nonselective adiabatic inversion pulse followed by a series of multiphase gradient EPI sequences to measure the spin lattice relaxation constant (T1) of flowing Blood. The new combined method of the fitting method and the nulling point method (CFN) is used to acquire more accurate and consistent T1. The simulation and experimental results show that this CFN method provides a more reliable measurement of the T1 of flowing blood.

480
E-POSTERS: Body and Musculoskeletal MR Imaging

2588. Weight-Bearing MRI of Patellofemoral Joint Cartilage
Garry E. Gold1, Thor F. Bester1, Christie E. Draper1, Deanna S. Asakawa1, Scott L. Delp1, Gary S. Beaupre1
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Patellofemoral pain syndrome (PFPS) is a common disorder in young adults manifest by anterior knee pain during locomotion and when climbing stairs. Patients with PFPS often have normal appearing cartilage on unloaded MRI scans. We used an MR compatible back support that allows motion-free 3D imaging of the patellofemoral cartilage under limited load in an open MRI scanner. Using this device, we were able to measure contact areas between the patella and femoral cartilage during flexion of 30 degrees, loaded and unloaded. Knowledge of contact areas enables calculation of patellofemoral stress, which may be increased in patients with PFPS.

2589. Investigation of Knee Cartilage with Rapid Combined 3-D T₁ and T₂ Mapping at 1.5 T
Joanna C. Suan1, Sean C. Deoni1, Brian K. Rutt1, David W. Holdsworth1
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Early osteoarthritic changes of proteoglycan loss and collagen framework disruption have been associated with variances in T1 and T2 relaxation times in cartilage. The use of quantitative relaxometry has been limited in the clinical setting due to the lack of a rapid, precise, and high-resolution T1 and T2 mapping technique. In this study, we have imaged two volunteers with asymptomatic and symptomatic knees using DESPOT 1 and DESPOT 2 relaxometry methods. We have demonstrated the clinical feasibility of full knee, high-resolution T1 and T2 mapping of cartilage in less than 45 minutes at 1.5 Tesla.

2590. In Vivo Analysis of Meniscal and Tibiofemoral Kinematics in Cruciate Ligament-Deficient Knees Using Kinematic Magnetic Resonance Imaging
Keh-Yang Lee1, C Benjamin Ma1, John P. Slavinsky1, Christina R. Allen1, Marc Safran1, Eugene Ozhinsky1, Sharmila Majumdar1
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Deficiency of the anterior or posterior cruciate ligaments can lead to altered knee and meniscal kinematics. Although cadaveric studies have demonstrated that cruciate ligament deficiencies can cause abnormal meniscal load, no studies have evaluated the changes in in vivo meniscal kinematics. In this study, a method using kinematic MRI is developed to assess abnormal meniscal and TF kinematics in cruciate ligament deficient knees. The results demonstrate that significant changes can be seen in the anterior tibial translation, contact area and meniscal position. This non-invasive analysis on in vivo biomechanics may allow us to predict meniscus injuries and premature osteoarthrosis.

2591. Effect of High Tibial Osteotomy on Patellar Kinematics in Loaded Flexion: A Three-Dimensional Kinematic MRI Study
Nicholas Hill1, Robert Fellows1, Norma MacIntyre1, Thomas Tang1, Mark Harrison1, Randy Ellis1, David Wilson2
1Queen's University, Kingston, Ontario, Canada; 2University of British Columbia, Vancouver, British Columbia, Canada

A recently developed magnetic resonance imaging-based measurement tool, with established accuracy and repeatability, was used to assess the effect of high tibial osteotomy (knee realignment surgery performed to treat osteoarthritis) on three-dimensional patellar tracking. Patellar tracking patterns were assessed pre- and post-operatively in 4 subjects who underwent closing wedge high tibial osteotomy. This study demonstrated that this MRI-based method is sensitive enough to accurately detect patellar tracking differences in vivo.

2592. dGEMRIC for Evaluation of Reparative Cartilage after Autologous Chondrocytes Implantation
Atsuya Watanabe1, Yuichi Wada1, Takayuki Obata2, Takuya Ueda1, Mitsuru Tamura2, Hideshige Moriya1, Hiroo Ikehira2
1Chiba University, Chiba, Japan; 2National Institute of Radiological Sciences, Chiba, Japan

Evaluation of glycosaminoglycan (GAG) concentration in reparative cartilage after autologous chondrocyte implantation (ACI) was performed with delayed gadolinium-enhanced MR imaging of cartilage (dGEMRIC). R1 relaxation rate measurements were made before and 2 hours after intravenous administration of Gd-DTPA2-. No correlation could be found between the GAG concentration of reparative cartilage evaluated by post-contrast imaging and that evaluated by HPLC. However, the GAG concentration of reparative cartilage evaluated by the difference between R1 before and after contrast administration is correlated with that evaluated by HPLC. Both pre-contrast and post-contrast images are indispensable for evaluation of reparative cartilage after ACI with dGEMRIC.
2593. **Use of Quantitative Dynamic Contrast MR Imaging to Monitor Musculoskeletal Sarcomas: Correlation with FDG PET and Pathology**

Leonard Marcal\(^1\), Haesun Choi\(^1\), Edward F. Jackson\(^1\), Robert S. Benjamin\(^1\), Asif Rashid\(^1\)

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Accurate evaluation of tumor response to pre-operative chemotherapy is of prime importance, in view of increased morbidity associated with delay in definite surgical treatment in patients with musculo-skeletal sarcomas. The current study demonstrate that the morphologic changes using tumor volume was a poor indicator of tumor response. SUVmax on FDG PET was a good indicator to monitor but IAUC, a dynamic MR imaging parameter, was the best indicator with all patients with >60% decrease showed >90% of tumor necrosis. The study was conducted with a rather small number of patients but demonstrated a great potential of IAUC of DCE MRI.

2594. **The Detection of Diffuse Bone Marrow Metastasis by Dual Phase Chemical Shift Imaging**

Eito Kozawa\(^1\), Waka Saito\(^1\), Makoto Amanuma\(^1\), Atsuko Heshiki\(^1\), Hidekazu Kayano\(^1\)

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Studies were performed to evaluate the usefulness of lumbar bone marrow MRI using the dual chemical shift sequence in the detection of diffuse bone metastasis. The chemical shift images (TE=2.3 msec and 4.7 msec) were obtained and SIR was calculated. SIR was designated as the ratio of in phase and out of phase signal intensity. Among 74 patients with suspicious lumbar bone metastases, diffuse bone metastases were present in 15 patients. The mean SIRs were compared by unpaired t test. SIRs of diffuse bone metastases had significantly higher of signal intensities than those of non-diffuse bone metastasis vertebrae (p<0.01).

2595. **Noninvasive Monitoring of Stem Cell Delivery and Muscle Regeneration**

Tiffany Nicole Frimel\(^1\), Kevin S. Cahill\(^2\), Gabriel S. Gaidosh\(^2\), Raquel T. Torres\(^2\), Johnny Huard\(^2\), Barry J. Byrne\(^2\), Krista Vandenborne\(^2\), Glenn Adam Walter\(^2\)

\(^1\)BRRC, Gainesville, Florida, USA; \(^2\)University of Florida, Gainesville, Florida, USA; \(^3\)University of Pittsburgh, Pittsburgh, Pennsylvania, USA

This study implemented noninvasive MRI techniques to monitor muscle stem cell transplantation and regeneration. A cast immobilization model was utilized to induce skeletal muscle damage and to initiate muscle regeneration during reloading. Multipotent muscle derived stem cells were delivered either by direct intramuscular or arterial injection into the abdominal aorta following 48 hours of muscle reloading. The presence of a small number of labeled cells caused large changes in MR contrast (T2 and T2*), allowing for non-invasive detection. MR imaging can be implemented to track the migration of a small number of labeled cells following arterial delivery.

2596. **Deficit of In Vivo Mitochondrial ATP Production in Patients with OPA1-Related Autosomal Dominant Optic Atrophy. A 31P-MRS Study of the Skeletal Muscle.**

Raffaele Lodi\(^1\), Caterina Tonon\(^1\), Stefano Iotti\(^1\), Valeria Clementi\(^1\), Emil Malucelli\(^1\), Maria Lucia Valenti\(^1\), Piero Barboni\(^1\), Lora Longanesi\(^2\), Bernd Wissinger\(^3\), Valerio Carelli\(^1\), Bruno Barbiroli\(^1\)

\(^1\)Università di Bologna, Bologna, Italy; \(^2\)Lugo Hospital, Ravenna, Italy; \(^3\)Universitats-Augenklinik, Tubingen, Tubingen, Germany

Autosomal dominant optic atrophy (ADOA), the most common form of hereditary optic neuropathy, in most patients is due to a mutation within the OPA1 gene (chromosome 3q28). OPA1 encodes a ubiquitously expressed GTPase related to dynamins, which is implicated in the formation and maintenance of mitochondrial network and morphology. We used 31P-MRS to assess calf muscle oxidative metabolism in six patients with ADOA due to a deletion in the OPA1 gene. The rate of post-exercise PCr re-synthesis was delayed (p<0.05) in the patients. Our in vivo results support the role of mitochondrial dysfunction in the physiopathology of OPA1-related ADOA.

2597. **Free Mg\(^2+\) Concentration in the Calf Muscle of Patients with Glycogen Phosphorylase and Phosphofructokinase Deficiency. A 31P MRS Study in Different Metabolic Conditions.**

Stefano Iotti\(^1\), Emil Malucelli\(^1\), Raffaele Lodi\(^1\), Bruno Barbiroli\(^1\)

\(^1\)University of Bologna, Bologna, Italy

In skeletal muscle the increase of cytosolic free Mg\(^2+\) occurring during exercise and initial recovery is matched by a decrease in cytosolic pH. We show by 31P MRS that in the skeletal muscle the homeostasis of intracellular free Mg\(^2+\) is linked to pH by assessing the changes of free Mg\(^2+\) concentration in a patient affected by a muscle phosphorylase deficiency (McArdle disease) and in two brothers affected by a phosphofructokinase (PFK) deficiency (Tarui disease). In PFK patients [Mg\(^2+\)] is decreased during exercise, suggesting that it binds accumulated phosphorylated monosaccarides intermediates of glycogenolysis.
2598. **Assessment of Local Extent of Rectal Carcinoma, Comparison between Fast-Recovery T2-Weighted Imaging and 16-Detector-Row CT Imaging with MPVR Technique**  
*Motoyuki Katayama*, Takayuki Masui*, Shuhei Yamashita*, Nobuko Yoshizawa*, Harumi Sakahara*  
1Seirei Hamamatsu General Hospital, Hamamatsu, Shizuoka, Japan; 2Hamamatsu University School of Medicine, Hamamatsu, Shizuoka, Japan

We assessed the local extent of rectal carcinoma with the comparison between dynamic contrast-enhanced MPVR imaging using MDCT and fast-recovery T2-weighted imaging with a pelvic phased array coil. Although T2-weighted MR imaging with a pelvic phased array coil has a high potential of diagnosis, its spatial resolution is inferior to CT images. A 16-detector-row CT study with the combination of MPVR technique and dynamic contrast enhancement enables to assess local invasion of the rectal tumor precisely, in addition to whole body screening.

2599. **Evaluation of Renal Vessels, Comparison between 2D FIESTA Imaging and Dynamic Contrast 3D Fast SPGR Imaging with ASSET**  
1Seirei Hamamatsu General Hospital, Hamamatsu, Shizuoka, Japan; 2GE Yokokawa Medical Systems, Hino, Tokyo, Japan; 3Hamamatsu University School of Medicine, Hamamatsu, Shizuoka, Japan

Synopsis 2D FIESTA imaging of renal vessels was compared with dynamic contrast 3D fast SPGR imaging. Although arterial phase of 3D dynamic fast SPGR sequence provided best renal arterial imaging, 2D FIESTA imaging was comparable to the venous and equilibrium phases, especially to evaluate aorta and venous structures.

2600. **MR Elastography of Human Kidney In Vivo: A Feasibility Study**  
*Scott A. Kruse*, M. Alex Dresner*, Richard L. Ehman*  
1Mayo Clinic & Foundation, Rochester, Minnesota, USA

Magnetic Resonance Elastography (MRE) is a noninvasive imaging technique that measures and quantifies mechanical tissue properties. It is hypothesized that MRE can be used to study diffuse diseases which are not well characterized by other imaging techniques. The purpose of this study was to obtain pilot data using the technique and to identify experimental factors that might influence the use of MRE to study renal parenchymal disease. MRE experiments were performed in 3 healthy volunteers. Breathhold scans were used to limit the effects of respiratory motion. This study established the feasibility of performing in vivo MRE of the kidney.

2601. **Endorectal Coil Magnetic Resonance Imaging (MRI) of the Prostate at 3 Tesla (3T) – Initial Experience**  
1Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA

We report the initial results of a systematic study to evaluate the clinical utility of endorectal 3T MRI. 9 volunteers were examined on 1.5 T and 3T scanners with combined pelvic phased-array and endorectal coils. T2-weighted fast spin-echo (FSE) and dynamic contrast enhanced (DCE) images were acquired. We achieved FSE images with 35 mm³ resolution, with good T2 contrast, no interfering artifacts, whole gland coverage in reasonable acquisition times while staying below the SAR limits. DCE-MR images show outstanding spatial resolution, demonstrating the clear clinical utility of endorectal 3T of the prostate with image quality not achievable at 1.5 T.

2602. **Segmentation of Breast MR Images via ITK Routines**  
*Ziji Wu*, Shilpa N. Kinkar*, John M. Sullivan, Jr.*, James Q. Zhang*, Udo Benz*  
1Dartmouth College, Hanover, New Hampshire, USA; 2Worcester Polytechnic Institute, Worcester, Massachusetts, USA

Medical Image segmentation is a challenging task. The Insight Segmentation and Registration Toolkit (ITK) is an open-source software released recently. It provides a basic set of algorithms that can be used to develop and customize a full segmentation application. We implemented a variety of these semi-automatic and automatic segmentation routines to delineate breast tissue components related to alternative imaging strategies being investigated. This implementation allows interactive adjustments of algorithm parameters. The consequences of such adjustments are immediately available via an intuitive visualization GUI. This system successfully segmented breast tissue and glandular ducts which were used to construct 3D geometry models.

2603. **Dynamic Contrast Uptake Analysis in the Breast by Linear Combination**  
*Logi Vidarsson*, Bruce L. Daniel*, Marowan Zakhour*, John Pauly*  
1Stanford University, Stanford, California, USA

Dynamic Contrast Enhanced (DCE) breast imaging can discriminate between many benign and malignant lesions. Studies have shown the diagnostic importance of the exchange parameter (k_e) in the two compartment model. Least squares (LS) based curve fitting is often used to estimate k_e. However this approach suffers from poor noise characteristics and long computation times. In this work we improve the LS curve fitting post processing approach with a faster linear combination (LC) method.
Poster Sessions

2604. Diffusion Imaging of Breast Cancer Using Single-Shot SENSE-EPI: Preliminary Results

Paul Weatherall1, Qi Peng1, Gregory Metzger1, Jon Chia1, Jihong Wang1
1University of Texas Southwestern Medical Center, Dallas, Texas, USA; 2Philips Medical Systems, Bothell, Washington, USA

Previous use of diffusion-weighted imaging (DWI) to evaluate breast cancer has provided tantalizing apparent diffusion coefficient (ADC) specificity values. However, multiple technical problems with its use result in a wide data variation in prior studies. We evaluated 15 patients with suspected malignancy, using a DWI technique that included parallel processing (SENSE) and eddy current correction. This combination alleviated many problems and provided data that compares favorably with that previously published. The increased exam speed and reduced distortion and artifacts using SENSE, will likely allow in vivo use of the DWI technique in the standard clinical environment.

2605. High Resolution 3T MR Mammography with Higher R-Factors

Bernice E. Hoppel1, Lisa C. Angelos1, LeRoy R. Blawat1
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With MRI emerging as a powerful tool, there is a need to assess greater morphological detail within the lesions without a dramatic decrease in temporal resolution. A scan speed increase comes from under sampling k-space in the slice direction. SNR is dependent on acceleration factors (2-4) because g-factor are close to 1.0. This abstract discusses the use of a 3T system for MRM, the coil specifically designed for this function and the use of parallel imaging to acquire higher resolution imaging in the sagittal plane.

2606. Incidence of Non-Viable Fibroids and Other Findings Resulting in a Decision Not to Embolize on Contrast-Enhanced Pelvic MR in Patients Referred for Uterine Artery Embolization.

Paul Nikolaidis1, James C. Carr1, Reed A. Omary1, Frank H. Miller1, Richard M. Mc Carthy1, Howard B. Chrisman1, Robert L. Vogelzang1
1Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA

Uterine artery embolization has recently revolutionized the treatment approach toward women with symptomatic fibroids. In addition to providing greater anatomic detail than ultrasound and aiding in the discovery of co-existing pelvic pathology, viability of fibroids is optimally assessed by contrast-enhanced pelvic MR. Pre-embolization gadolinium-enhanced MR is highly useful in the evaluation of patients referred for UAE. In over one fifth of patients, MR findings resulted in a decision not to proceed with UAE. In addition to the discovery of coexisting pelvic pathology, including adenomyosis and endometrial lesions, viability of fibroids can be assessed by contrast-enhanced MR prior to embolization.

2607. MRI Appearance of an Unusual Manifestation of Septate Uterus

Gisela Mueller1, Yolanda Smith1, Elisabeth Quint1, John Delancey1, Ruth Carlos1, Hero Hussain1
1University of Michigan, Ann Arbor, Michigan, USA

Determination of Mullerian anomalies is critical for determination of clinical management; however, classification of these anomalies can be difficult. We present a series of cases describing an unusual manifestation of septate uterus that can lead to a variance in clinical management.

2608. MRI of Human Lung Cancer in Animal Models

Yael Rosen1, Edna Furman-Haran1, Maya Dadiani1, Raanan Margalit1, Hadassa Degani1
1The Weizmann Institute of Science, Rehovot, Israel

Lung cancer is the leading cause of cancer death. Our aim is to develop MRI methods for its detection and characterization by studying both primary lung cancer and lung metastases of breast cancer in animal models. The primary lung cancer grew as heterogeneous masses well distinguishable in the T2-weighted images, and showed mainly a pattern of fast wash-in and wash-out of the contrast-agent. The metastases in the lungs were spread throughout the lungs as was detected by the T2-weighted images, and the contrast-enhancement patterns were heterogeneous, suggesting the need for developing new analysis tools.

2609. 3-D Lung Motion Estimation Via Non-Rigid Registration Using Volumetric MR and CT

Tessa Sundaram1, James Gee1, Mizuki Nishino2, Shigeru Kiryu2, Yasutane Mori2, Masaomi Kuroki2, Masaya Takahashi2, Hiroto Hatabe2
1University of Pennsylvania, Philadelphia, Pennsylvania, USA; 2Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

Quantification of pulmonary deformation is useful in characterizing normal lung motion as well as the effects of pathological processes. We use finite element-based non-rigid registration to quantify pulmonary motion between sequential CT and MR volumes. The results provide regional information about deformation of the whole lung through the respiratory cycle. The MR data produces equivalent results to the CT data with better vascular image contrast, and without the requirement for radiation exposure or intravenous contrast agents. One ultimate goal of this work is the construction of a dynamic lung and further in vivo MR quantitation of regional pulmonary biomechanics.
2610. **Modelling Respiratory Motion for Optimisation of Lung Cancer Radiotherapy Using Fast MR Imaging and Intensity-Based Image Registration**

Jane Blackall\(^1\), Shahreen Ahmad\(^2\), Marc Miquel\(^1\), David Landau\(^2\), David Hawkes\(^1\)

\(^1\)King's College London, London, UK; \(^2\)Guy's and St. Thomas' NHS Trust, London, UK

This work investigates complex 3D lung motion and deformation in healthy volunteers using 3D free-breathing dynamic FFE-EPI images and breath-held Steady State Free Precession images and an intensity-based affine image registration method in order to create subject-specific models of breathing. Such models predict motion and deformation of the lung due to respiration during treatment, thereby allowing a reduction of margins in radiotherapy planning target volumes and, ultimately, improving patient outcomes.

2611. **Perfusion Quantification of the Whole Lung using Singular Value Decomposition with Optimized Threshold**

Frank Risse\(^1\), Christian Fink\(^1\), Sebastian Ley\(^1\), Hans-Ulrich Kauczor\(^1\), Lothar R. Schad\(^1\)

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Model-independent quantification of contrast-enhanced bolus tracking measurements requires deconvolution methods such as singular value decomposition (SVD). Due to the inhomogeneity of lung tissue, an optimized singular value threshold considering the local signal-to-noise ratio (SNR) is required. Several lung perfusion conditions were simulated to obtain optimal thresholds depending on the SNR. The efficacy of SVD analysis with optimized threshold was evaluated in volunteer measurements using 3D FLASH with parallel imaging. It was feasible to apply the method to 3D lung data sets and the calculated pulmonary blood flows and mean transit times were in the same range as in published data.

2612. **"Diffusion PETgraphy": Technical Breakthrough in Body Diffusion Weighted Images with Non-Breath-Holding and High Resolution 3D Display.**

Taro Takahara\(^1\), Eiko Yamashita\(^1\), Seiji Nasu\(^1\), Misako Iino\(^1\), Jun Koizumi\(^1\), Yoshiro Iwata\(^1\), Yutaka Imai\(^1\)

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Previously, breath-holding was considered necessary for body diffusion weighted images (DWI). However we showed that adequate high resolution DWI can be achieved without breath-holding. Furthermore, STIR-DWI was useful in eliminating potential problems of insufficient fat suppression frequently appearing in the periphery of FOV resulting in an unreadable MIP image. We believe that non-breath hold STIR-DWI is a significant breakthrough and anticipate that it can be applied to whole-body MRI screening of malignant lesions as "Diffusion PETgraphy" in the near future.

2613. **Does Virtual Colonography Reveal Relevant Pathologies in Patients with Incomplete Endoscopy?**

Thomas C. Lauenstein\(^1\), Waleed Ajaj\(^1\), Susanne C. Goehde\(^1\), Christoph U. Herborn\(^1\), Gerald Holtmann\(^1\), Stefan G. Ruehm\(^1\)

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We aimed to evaluate the impact of MR colonography (MRC) in patients with incomplete conventional colonoscopy. 37 patients were included.Incomplete colonoscopy was due to stenoses of the bowel lumen, elongated colonic segments or severe pain. Patients underwent a dark-lumen MRC examination based on the acquisition of T1w data sets pre and post i.v. gadolinium administration. Two colonic carcinomas as well as nine minor lesions (polyps, inflamed bowel segments) were detected in those parts of the colon that had not been reached by endoscopy. We conclude that MRC should be performed in all patients with incomplete endoscopy.

2614. **MRCP Assessment of the Efficacy of Pancreatic Rest in Patients with Acute Pancreatitis on Enteral Feeding**

Alice Gillams\(^1\), William Lees\(^1\)

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Pancreatic rest is important in the treatment of acute pancreatitis but the optimal method remains controversial. Dynamic MRCP can be used to assess pancreatic output in response to Secretin. We studied pancreatic response to enteral feeding in 8 patients with acute pancreatitis. In 5/8 the pancreatic response was weak or absent. In 3 the response was modest. Median flow rate was 0.3ml/min (0.04 – 1.1). This technique can be used to assess the impact of tube positioning, the effectiveness of Octreotide and to monitor pancreatic rest in individual patients. This represents a new application for MRCP.

2615. **Detection and Characterization of Hepatocellular Carcinoma with Ferucarbotran-Enhanced Perfusion MR Imaging**

Nobuhiko Ogasawara\(^1\), Hisato Kobayashi\(^1\), Kotaro Shimada\(^1\), Yusuke Kigami\(^1\), Keizo Akuta\(^1\)

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Feasibility of ferucarbotran-enhanced perfusion MRI using a single-shot GRE-EPI for detection and characterization of HCC was studied. 34 HCC in 20 patients were examined. Total 91% of the HCC were detectable. 2 of 3 lesions not detected by dynamic EPI were hypovascular tumor. In all lesions detectable, early enhancement was recognized. In some lesions, delayed washout was not recognized, suspected due to SPIO-uptake to the tumor. Earlier plateau time than arrival time to portal vein was additional character of hypervascular HCC in this technique. Ferucarbotran-enhanced perfusion MRI has excellent detectability of hypervascular HCC and can adequately assess the tumor vascularity.
2616. The Liver Enhancement Patterns of a New Dual Contrast MR Agents with Moderate Molecular Weight
Yongmin Chang1, Hyun-Jung Park1, Young-Whan Chang2, Ji-Ae Park1, Dong-Kyu Park1
1Kyungpook National University, Daegu, Republic of Korea; 2Korea Advanced Institute of Science and Technology, Daejun, Republic of Korea

A new hepatobiliary dual contrast MR agent, MnPC, is synthesized. This agent, on T1-weighted image, enhances both the normal portion of liver parenchyma and the tumor rim in rabbit model of VX-2 carcinoma. Signal decrease of normal liver parenchyma on T2-weighted image suggests MnPC can be used as a dual contrast MR agent with liver specificity.

2617. Dynamic Contrast MR of Hepatic Hemangiomas: Evaluation of Temporal Signal Intensity Changes
Larry Allen Kramer1, Khader M. Hasan1, Thuan T. Vu1
1University of Texas, Houston, Texas, USA

We measured the temporal signal intensity changes of hepatic hemangiomas, hepatocellular carcinoma, focal nodular hyperplasia and hepatic adenoma on dynamic MR relative to the abdominal aorta to determine if similarities existed. We found that hepatic hemangiomas only correlated with the signal intensity of the abdominal aorta at 3 minutes whereas hepatocellular carcinoma was poorly correlated up to 5 minutes. Focal nodular hyperplasia and hepatic adenoma correlated well at 45 seconds. These results indicate that signal intensity measurements may be a useful technique in characterizing lesions when analysis of enhancement pattern and T2 signal intensity changes are problematic or equivocal.

2618. Evaluation of Periportal Collar with Black-Blood T2-Weighted SE-EPI Imaging of the Liver
Yuji Watanabe1, Masako Nagayama1, Akira Okumura1, Takashi Tabuchi1, Hideki Mitsui1, Noriyoshi Morimoto1, Kazuaki Nakada1, Masayuki Kumashiro1, Shinsuke Komaki1, Takashi Kiyono1, Yoshiki Amoh1, Satoru Nakashita1, Marc Van Cauteren1, Yoshihiro Dodo1
1Kurashiki Central Hospital, Kurashiki, Okayama, Japan; 2Philips Medical Systems, Best, DA, Netherlands

Newly-developed black-blood T2-weighted images of the liver were obtained by applying very low b-factor (b=8) motion-probing-gradient for single-shot SE-EPI sequence. This method allowed for complete elimination of flow signal even in a sluggish flow of portal or hepatic vein, which allowed the accurate assessment of periportal collar. Black-blood T2-weighted SE-EPI images were obtained with TE set at 90 and 200, which enabled to differentiate periportal lesions from dilated intrahepatic bile duct. The hyperintensity of periportal collar on TE90 images was unevenly thick and prominent in the patients with malignant neoplasm when compared with inflammatory process.

2619. Breath-Hold Quantitative Perfusion Imaging of the Kidneys at 3 T by FAIR True-FISP
Petros Martirosian1, Uwe Klose1, Irina Mader1, Gunter Helms1, Hansjörg Graf1, Michael Fenchel1, Claus Detlef Claussen1, Fritz Schick1
1University of Tübingen, Tübingen, Germany; 2University of Freiburg, Freiburg, Germany

In arterial spin labelling (ASL) techniques for perfusion imaging respiratory motion reduces image quality and might influence quantitative results in abdominal studies. The sensitivity of the ASL methods is expected to improve for higher field strength. Breath-hold measurements of the kidneys of healthy volunteers were performed on a 3 T scanner using a novel FAIR True-FISP technique. Perfusion images of good quality were obtained in several seconds of measuring time. The calculated perfusion rates are in good agreement with previous ASL studies.

2620. Human Gallbladder Bile: Enhancing the Sensitivity of Single-Voxel 1H-MRS using WET Solvent Suppression and Short TE Methodology
Andrew P. Prescot1, David J. Collins1, Martin O. Leach1, Andrzej SK Dzik-Jurasz2
1Institute of Cancer Research and Royal Marsden NHS Trust, Sutton, Surrey, UK; 2GlaxoSmithKline, London, UK

The aim of this study was to determine whether the sensitivity of single-voxel 1H-MRS of human gallbladder bile could be improved using the WET solvent suppression scheme and short TE 1H-MRS methodology. The WET module was integrated into a conventional PRESS 1H-MRS sequence (TR = 1500 ms, TE = 25/60 ms) and a series of spectra were acquired from three male volunteers at 1.5 T. The results demonstrate that WET achieves superior water suppression factors compared to CHESS for extracranial 1H-MRS measurements. In addition, short TE 1H-MRS may permit the further detection of conjugated bile acid and biliary cholesterol resonances.

2621. Improved Sensitivity of the Reversible Component of the Transverse Relaxation Rate (R2') in Iron-Overloading Diseases
Hee Kwon Song1, Yan Zhang1, Felix W. Wehrli1
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MRI is an excellent tool for iron quantification in diseases causing its accumulation in the body. Although spin-echo sequences are sensitive to increased iron levels, other studies have shown that gradient-echo can often be more predictive. In this work, the various components of the transverse relaxation are measured using an efficient, single scan GESFIDE (gradient-echo sampling of free induction decay and echo) technique. Preliminary results in liver of a thalassemic mouse and in vivo in a patient with thalassemia suggest that R2' (=1/T2'), the reversible component of the transverse relaxation, may be the most sensitive parameter for determining iron content.
2622. SPIO-MR Lymphography for Detection of Lymphatic Pathway in Patients with Thoracic Esophageal Cancer
Koichi Ishiyama1, Ryuji Sashi1, Satoru Motoyama1, Noriaki Tomura1, Komei Narita1, Jiro Watarai1
1Akita University School of Medicine, Akita, Japan

SPIO-MR lymphography was undertaken in 20 patients with thoracic esophageal cancer. A total of 2 ml ferumoxides was administered into the submucosal layer of the peritumoral areas. 2D-fast SPGR images (TR/TE=90/4.2 msec) were acquired at the neck and upper thorax and upper abdomen. All patients showed the decreased signal intensity of lymph nodes 32.2 ± 16.2 min after injection of ferumoxides. These showed the direction of lymphatic pathway from the tumor and their anatomical location precisely. The present results suggest that this new technique is potentially useful for determining the removal area of the lymph nodes in patients with esophageal cancer.

2623. Fractal Analysis of Pulmonary Perfusion Deficits in Arterial Spin Labeled MR Techniques
Naveen Gumpeni1, David L. Levin1, Hiroyuki Sasaki2, Qun Chen4, Robert R. Edelman5, Pottumarthi V. Prasad6, Vu M. Mai5
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Fractal analysis was performed on FAIR and FAIRER perfusion images from healthy control subjects and patients with known pulmonary disease, such as emphysema, pulmonary embolus or neoplasm. Healthy subjects were compared to patients with respect to their fractal dimension values obtained from perfusion deficits as seen in binary (2D) images or grayscale (3D) images. Significant differences in the 2-dimensional fractal dimension suggest that perfusion deficits seen in FAIR/FAIRER images show less self-similarity and dimensionality than normally perfused lung parenchyma, as evidenced by lower fractal dimension values obtained from the binary images.

2624. Retrospective Registration of Hepatic MR Images
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We compared mutual information (MI) and surface based head-in-hat (HH) registration for retrospectively aligning CE MR images of the liver (pre, hepatic, portal). Livers were hand segmented from the images. The surfaces of the segmentations were used for the HH algorithm. For the MI registration only the target (hepatic) was segmented. Images had large slice thicknesses (10 mm, compared to 1.1-1.5 mm in plane resolution). Mean residual displacements for MI was 8.2 mm compared to 9.2 mm for HH. These results, which are on the order of the slice thickness, are reasonable for the resolution of the images.

2625. Detecting Contralateral Breast Lesions with Bilateral Breast MRI
Hatsuko Nasu1, Yasuo Takehara1, Satoshi Isogai1, Kouichi Sugiyama1, Masahiro Sugiyama1, Hiroaysu Takeda1, Tatsuya Igarashi1, Harumi Sakahara1
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380 patients with suspected breast lesions were examined with bilateral breast MRI using breast-array coil. MR detected 34 contralateral breast lesions in 28 of 380 patients (7.4% individuals). Synchronous breast cancer on the contralateral side was 3.2% of 250 patients with index carcinoma, which was 29% of 28 patients with contralateral (MR detectable) breast lesions, and 50% of 16 patients who underwent biopsy of the contralateral (MR detectable) breast lesions. Although the clinical importance of picking out contralateral breast cancer remains to be defined, the method has shown its potential as a sensitive screener for contralateral breast lesions including cancers.

E-POSTERS: Magnets and Related Systems

2626. Development of an In-Theatre Brain Biopsy Proton Spectroscopy System
Martyn NJ Paley1, Nick Kerley2, David Rayner2, David Cardwell3, Fred Eastham4, David Thomas5, Ian Young6
1University of Sheffield, Sheffield, UK; 2Magnex Scientific, Oxford, Oxfordshire, UK; 3University of Cambridge, Cambridge, Cambridgeshire, UK; 4Enigmatec Ltd, Bath, Avon, UK; 5Institute of Neurology, London, UK; 6University of Sheffield, Sheffield, Yorkshire, UK

A compact 8.5T magnet and 360 MHz spectrometer have been developed for use as an in-theatre brain biopsy proton spectroscopy system. The magnet uses a sealed cryogenic pulse tube cooler and has a fringe field which is contained within the magnet spectrometer. Initial testing shows that the system will be useful for installation in sites with space limitations. Future work will compare proton spectroscopy with histology for brain biopsy samples.
2627. A B0 Compensation Coil of a 0.3T Permanent MRI System
Xiaomin Zhu1, Xiaohua Jiang1, Guanghui Shen2
1Tsinghua University, Beijing, People's Republic of China; 2Electrical Engineering Department, Beijing, People's Republic of China

A B0 compensation coil is developed to compensate for the field drift of a 0.3T permanent MRI magnet caused by temperature shift. The Integral Equation Method (IEM) is firstly employed for the coil design, emphasizing on the optimization of the coil structure. By use of the two-dimensional (2D) Finite Element Method (FEM) code of ANSYS; the optimization results are verified and modified to obtain better performances. Both design and experiment data show that the temperature drift is compensated effectively and the drift of the field uniformity caused by the compensation coil is in a reasonable range.

2628. Low Cost NMR/MRI Spectrometer using Industrial Boards
Christian Goetz1, Philippe Choquet1, Jean Noël Hyacinthe2, André Constantinesco1
1Hôpital de Hautepierre, Strasbourg, France; 2Université J Fourier, CHU, Grenoble, France

Commercial NMR spectrometers are made of several complex, specifically developed high cost devices. We choose to construct a low cost NMR spectrometer based on standard electronic boards integrated through software and whose basic principle rely on direct pass band sampling of NMR signal. At present, the spectrometer allow RF coils wobulation and matching, relaxation times measurements and images acquisition with spin and gradient echo sequences. First results show no difference in image quality compared with standard spectrometer. This system offer an alternative for low cost applications of MRI (industry, teaching...).

2629. Minimizing Field Inaccuracy in MRI Electromagnet Control Systems
Nathaniel I. Matter1, Steven Conolly1, Greig Scott1
1Stanford University, Stanford, California, USA

We characterized the fundamental limits on sensor performance of an electromagnet control system. We also identify all sources of error in an electromagnet control system with the intent of developing a smart electromagnet control system capable of eliminating all sources error that are not due to fundamental limits of the control electronics or coil and achieving temporal field stability for a pulsed coil MR system as close a possible to that of a superconducting system.

2630. Rapid Field Pulsing Circuit with Leakage Current Bypass for Pulsed Magnetic Coils in MR
Nathaniel Matter1, Steven Conolly1, Greig Scott1
1Stanford University, Stanford, California, USA

We designed and constructed a scalable circuit that can rapidly pulse a volumetric MR coil when inserted between the coil and a power supply sufficient only for powering the coil at steady state. This modular arrangement greatly relaxes the requirements of the power supply circuitry by decoupling the high voltage transients and the DC regulation. The pulsing circuit was configured to pulse a MRI prepolarizing coil (up to 0.5 T, 12 cm inner diameter) with 13 ms ramp times. The problematic semiconductor off-state leakage currents were bypassed around the coil to minimize B0 field disturbance.

2631. A Parallel Computing Solution for Rapid Reconstruction of Highly-Accelerated Volumetric Parallel MRI Data
Shmuel Cohen1, Aaron K. Grant1, Ernest N. Yeh1, Sanjay Joshi3, Daniel K. Sodickson1
1Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; 2Harvard-MIT Division of Health Sciences and Technology, Boston, Massachusetts, USA; 3General Electric Medical Systems, Milwaukee, Wisconsin, USA

The use of large coil arrays for highly parallel volumetric imaging creates very large data sets that stress the capability of current off-line reconstruction algorithms. Serial reconstructions on individual workstations result in long time delays before an image set can be presented to users. Our goal in this work was to reduce the image reconstruction turn-around time for acquired images by use of a low cost cluster of computers, delivering results to the clinical workstation before the patient leaves the MRI magnet, while maintaining the use of high-level software (MATLAB) to facilitate the rapid prototyping of new applications and algorithms.

2632. Real-Time Gradient Non-Linearity Correction
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Applications requiring fast and accurate representations of location, such as real-time interventional procedures, require real-time correction of gradient non-linearity. Current methods correct for both spatial and intensity distortion of the object being imaged through post-processing routines that take considerable time. A new real-time method is proposed for gradient non-linearity correction that takes advantage of current graphics technology and treats the acquired image as a surface of gradient iso-contours.
**E-POSTERS: RF Coils and Arrays**

**2633. A Novel 10-Element Array Coil for Head Parallel Imaging at 1.5T**

Hiroyuki Fujita¹, Steve Zhang¹, Shinji Mitsui¹, Michael Donofrio¹, Victor Krantz¹, Jacob Weaver¹, Erik Fowler¹, Yasutake Yasuhara², Kazuya Okamoto², Kazuto Nakabayashi²

¹USA Instruments, Inc., Aurora, Ohio, USA; ²Toshiba Medical Systems Corporation, Otawara, Tochigi, Japan

We report a novel parallel-imaging (PI) compatible 10-element array coil for head imaging at 1.5T. The coil was designed to optimize SNR and PI capability in the x, y and z directions. The head and brain areas are covered with 4 QD pairs, and the nose/mouth area is surrounded by 2 loops, constituting a complete head coil. This coil was compared with a standard QD head coil, yielding in-plane average of 50 to 60% more SNR at a central axial slice. The SNR improvement enables achieving clinically acceptable image quality even when parallel imaging technique is applied.

**2634. The SENSE CTL Coil for 3T 8-Channel MRI Systems**

Limin Feng¹, Vincent Chen¹, Karthik Lakshmanan¹, Yun Jeong Yang¹

¹USA Instruments, Inc., Aurora, Ohio, USA

A new Cervical-Thoracic-Lumbar (CTL) spine coil consisting of 14 element coils is designed for the 3T MRI system with eight RF receive channels. Due to the distribution of the high radio frequency electromagnetic filed inside the human body affected by the dielectric and conductivity of the tissue, the spine images acquired by the traditional CTL coil that consists of quadrature loop and saddle coils has left-right shading. The new CTL coil with 3-loop structure has solved the left-right shading problem and maintained the SNR in the spine area. It also provides additional SENSE imaging capability in LR phase encoding direction.

**2635. Optimization of Longitudinal Sensitivity in Multi-Element Opposed Solenoid Intravascular Imaging Coils**

Eddy Y. Wong¹, Claudia M. Hillenbrand², Jonathan S. Lewin², Jeffrey L. Duerk²

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Traditional opposed-solenoid imaging coils are useful in intravascular imaging applications because of their homogeneous sensitivity profiles. However, they provide only limited longitudinal coverage, thus limiting their utility to primarily axial imaging. Multi-element opposed solenoid coils have been proposed as a means to address this shortcoming. In this work, we employ BioT-Savart computer simulations to examine the relative spacing between opposed-solenoid elements in order to produce a multi-element opposed-solenoid vascular catheter-coil that is optimized for a homogeneous sensitivity profile in the longitudinal direction as well as maintaining the radial homogeneity of a standard two-element opposed-solenoid imaging coil.

**2636. An Array Structure for Improved Endoanal Imaging**

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Endoanal coils provide a high local signal-to-noise ratio (SNR) when compared to external surface coils and have proved valuable in the diagnosis and treatment of anal sepsis, incontinence and tumors. These insertable coils, based on a single extended-loop structure, are a compromise. Coil length is dictated by the field of view (FOV) required, whilst optimal SNR is shown to require much smaller axial dimensions. We therefore propose a 4-element array design which is shown to achieve >5dB SNR gain over our existing coil at 1.5T. 8-element structures are also being investigated.

**2637. Hybrid Intravascular Imaging Coils**

Eddy Y. Wong¹, Claudia M. Hillenbrand², Jonathan S. Lewin², Jeffrey L. Duerk²

¹Case Western Reserve University, Cleveland, Ohio, USA; ²University Hospitals of Cleveland, Cleveland, Ohio, USA

In this work a novel intravascular coil design, which combines the opposed-solenoid and single-loop antennas into a single unit, is introduced and evaluated. Opposed-solenoid imaging coils provide homogeneous radial sensitivity profiles ideal for high-resolution intravascular imaging. However, their application in survey imaging for pathology identification is poor due to reduced longitudinal coverage. In contrast, loop antennas show limited radial field homogeneity but offer extended longitudinal coverage. In this work, we employ BioT-Savart computer simulations to examine the hybrid coil’s ability to overcome problems associated with the individual designs. Finally, a hybrid coil is constructed and tested in imaging experiments.

**2638. A Local Coil Design with CR-LOOP for Low Field MRI**

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With the development of MRI, more and more concern is located in how to enlarge FOV. This paper analyzes the shortcoming of the present design of extremity coil with only LOOP and SADDLE coil element. Based on this, the paper proposes a new design by adding a CR-LOOP coil element. In this way, we can increase both SNR and FOV and improve the imaging quality. Moreover, the coil size needn’t to be increased, which is a very important aspect for coil design for easy patient handling.
2639. Comparison of Surface Coil and Automatically-Tuned, Flexible Interventional Coil Imaging in a Porcine Knee
Ross Venook¹, Brian Hargreaves¹, Steven Conolly¹, Garry Gold¹, Greig Scott¹
¹Stanford University, Stanford, California, USA

This work presents comparisons between a 3-inch surface coil, and a novel 1-inch, automatically-tuned, flexible interventional coil in an in vitro porcine knee model. We used a GE Signa 1.5T scanner and product 3D SSFP sequence to produce 234x234x700 µm³ images of patella-femoral cartilage, and 586x586x1000um³ images of the posterior intra-condylar notch of the femur. Analysis revealed 2-3 and 5-7 fold increases in SNR of the patella-femoral cartilage and of the posterior intra-condylar notch, respectively. Because of tremendous gains in local SNR, and because automatic tuning preserves SNR under dynamic conditions, flexible coils support promising new methods in interventional MRI.

2640. Development of a Reconfigurable MRI Coil using Electrostrictive Polymer Artificial Muscle Actuators
Daniel F. Kacher¹, John Vogan², Moustafa Hafez², Jon-Sebastian Plante², Steven Dubowsky², Ferenc A. Jolesz¹
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The function of a conventional surface coil is limited by its fixed dimensions. Optimal image quality results when the sensitivity profile of the coil is matched to the volume of the sample. For a single coil, the coil may be moved or replaced with a coil of different dimensions to improve image quality, which requires the sample be removed from the bore of the scanner. This article presents a new method for remotely varying the dimensions and location of the coil with Electrostrictive Polymer Artificial Muscles (EPAM). Experimental results prove both MRI compatibility and potential for useful MRI-EPAM devices.

2641. SNR Comparison of RF Coil Size for Ischemic Skin Imaging
Julie Camille DiCarlo¹, Steve Conolly¹, Greig Scott¹, Brian A. Hargreaves¹, Neal K. Bangerter¹, Charles Cunningham¹, Jin H. Lee¹, Bob S. Hu¹, Dwight G. Nishimura¹
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There is a clinical need for early diagnosis of peripheral vascular disease. MR imaging is a potential tool for diagnosis by evaluating both morphology and physiology. The ideal MR-based skin perfusion imaging component would combine high-resolution, high-speed imaging with coils optimized for imaging of the hypodermic layer of the skin. We focus on the selection of RF receive coil parameters for this application. Specifically, we construct coils of different sizes and analyze the optimal trade-off between SNR gain and increasing resistive coil loss with decreasing coil size.

E-POSTERS: Parallel Imaging

2642. RF Pulse Design Tradeoffs Enabled by Parallel Imaging
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We describe a new method for limiting the size of a 3D excitation slab. We use parallel imaging (ASSET) to correct slab wrap arising from tradeoffs in RF profile design. By relaxing slab wrap constraints, we gain flexibility in RF pulse design. We apply this technique to SSFP scans, where short RF pulses are necessary to achieve repetition times short enough to minimize off-resonance artifacts.

2643. Diamond-SENSE: Undersampling on a Crystallographic Grid
Michel Jurrissen¹, Miha Fuderer¹, Johan van den Brink¹
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In 3D scans, SENSE can be applied by undersampling in two phase encoding directions. To obtain optimal image quality with SENSE it is necessary to undersample in both phase encoding directions. With an undersampled rectangular grid the profiles are not optimally distributed in k-space. In this work we propose to acquire profiles on a crystallographic grid, this method is called Diamond-SENSE. By undersampling on a crystallographic grid the reconstruction quality is improved. Diamond-SENSE provides opportunities for very high SENSE reduction factors.

2644. Spiral Navigated Sensitivity Calibration for Parallel Imaging
Kevin F. King¹, Lisa Angelos¹, Jason Polzin¹
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Parallel imaging methods including SENSE and SMASH use receive coil B1 field (sensitivity) maps to either remove aliasing or restore missing k-space lines. The sensitivity map is measured using either a separate scan or extra Nyquist-sampled lines near the center of k-space within the parallel imaging scan (self-calibration). We describe a new approach, navigated sensitivity, which combines benefits of the separate scan and self-calibration methods by appending a short calibration acquisition to the parallel imaging scan. A spiral calibration is attractive because it is particularly fast and moderate blurring that is normally problematic with spirals has little detrimental effect.
2645. **Fitting Coil and Data in Parallel Imaging**  
*Philip Batchelor*,  
Kings College London, London, UK;  
*David Atkinson*,  
Kings College London, London, UK;  
*David Larkman*,  
Imperial College London, London, UK;  
*Jo Hajnal*  
Imperial College London, London, UK

Parallel imaging reconstructions using SMASH and SENSE require an estimate of the coil spatial sensitivities. These vary depending upon the coil loading and so must be determined on a patient specific basis, by acquiring an extra reference scan. The maximum speed-up factor for parallel imaging is the number of coils, but speed-up factors less than this are frequently used. This leaves some extra information which may be sufficient to obtain the coil sensitivity profiles. Here, we investigate the use of directly fitting image data and parameters for the coils to the data acquired with speed up.

2646. **TurboSENSE: Phase Estimation in Temporal Phase-Constrained Parallel Imaging**  
*Calvin Lew*,  
Stanford University, Stanford, California, USA;  
*Dan Spielman*,  
Stanford University, Stanford, California, USA;  
*Roland Bammer*  
Stanford University, Stanford, California, USA

Phase-constrained SENSE for multiple-pass imaging requires an accurate phase estimate per pass. The performance of the net total number of phase encodes collected using this method is compared to conventional SENSE. Initial results show that there is some net speedup without significant loss of performance. Phase-constrained SENSE shows more robustness to higher reduction factors due to smaller g-factors, although the errors from the phase estimate provide a limit to image quality.

2647. **Phase-Constrained Reconstruction of Sensitivity-Encoded MRI Data with POCSENSE**  
*Alexei Samsonov*,  
University of Utah, Salt Lake City, Utah, USA;  
*Evgeni Kholmovski*,  
University of Utah, Salt Lake City, Utah, USA;  
*Chris Johnson*  
University of Utah, Salt Lake City, Utah, USA

Phase-constrained reconstruction of sensitivity-encoded MRI data promises a lot of benefits such as improved image quality, increased SNR and increased imaging speedup. We present a method for phase-constrained reconstruction of such data using POCSENSE technique. The new method is flexible in the use of phase constraints of different origins in reconstruction of sensitivity-encoded data sampled on arbitrary k-space trajectories. The distinctive advantage of the phase-constraining with POCSENSE is its algorithmical simplicity and computational efficiency. The POCS formalism used in the method opens space for the inclusion of additional constraints for further improvement of image quality.

2648. **Non-Cartesian POCSENSE**  
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*Chris Johnson*  
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In this abstract, we propose an extension of POCS-based method for reconstruction of sensitivity-encoded MRI data (POCSENSE) to non-Cartesian trajectories. The reconstruction is accomplished using a series of k-space gridding interpolations to perform data projection operation. The new method retains all attractive properties of the original POCSENSE algorithm, namely, computational efficiency, algorithmical simplicity, and easiness of inclusion of many nonlinear constraints in the image reconstruction. The results of method validation on phantom spiral dataset are presented.

2649. **SNR Increase in Modified VD-AUTO-SMASH Imaging**  
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*Zhigang You*,  
University of Rochester, Rochester, New York, USA;  
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Despite its usefulness in shortening imaging time, parallel imaging such as SENSE and SMASH usually has a SNR decrease compared to conventional imaging. Since VD-AUTO-SMASH uses a variable k-space sampling density, the image noise properties may be different from regular SMASH. A modified VD-AUTO-SMASH (MVAS) technique was recently developed that significantly reduces image artifacts in VD-AUTO-SMASH, and gives more accurate SNR measurement. We studied the SNR properties of MVAS using computer simulation, phantom and in vivo imaging. The results show that there can be simultaneous increases in both SNR and scan speed in MVAS over conventional sum-of-square MR imaging.

2650. **Improved Contrast to Noise per Unit Time “CNR/t” at 3Tesla using Parallel Imaging (SENSE) with 3D Spoiled Gradient Recalled Echo for Dynamic Contrast Enhanced MR Imaging DCE-MRI**  
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National Institute of Health, Bethesda, Maryland, USA;  
*Gregory J. Metzger*,  
Philips Medical Systems, Cleveland, Ohio, USA;  
*Peter Choyke*,  
Johns Hopkins, Baltimore, Maryland, USA;  
*John Butman*,  
Philips Medical Systems, Cleveland, Ohio, USA

We present a method to increase the contrast to noise per unit time “CNR/t” at 3 Tesla using a 3D SP-GRE acquisition in conjunction with parallel acquisition processing “SENSE”. 3D SP-GRE is a very time efficient way to cover volumetric k-space however the CNR/t suffers due to the combined imaging time constraint imposed by high temporal resolution dynamic contrast enhanced acquisitions coupled to the reduced T1 contrast inherent at 3 Tesla and short TR acquisition strategies. Here we take advantage of the flexibility afforded by parallel processing with array coils and reconstruction algorithms to optimize CNR/t at 3T.
Common SENSE is a new method to perform segmented Gradient Echo-EPI (GE-EPI) in a single-shot. A novel pulse sequence obtains two half Field of View (FoV) images in rapid succession with a sinusoidal modulation in sensitivity. To produce a full FoV image, the half FoV images are combined as if they were images from multiple coils in a SENSE experiment. This method has the advantages of a two-shot interleaved GE-EPI acquisition (i.e. reduced distortion and blurring), without the normal disadvantages of segmented GE-EPI (i.e. sensitivity to mismatches between data segments that causes ghosting or a penalty in temporal resolution).

E-POSTERS: Pulse Sequences and Other Techniques

2652. Frequency Selective RF Pulses for Multislice MRI with Modest Immunity to B1 Inhomogeneity and to Resonance Offset
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We have developed computer optimization methods to seek out new three and four pulse rectangular composite pulse sequences that have immunity to both B1 inhomogeneity and resonance offset. These sequences then form an improved basis for generation of slice selective pulses that confer both immunity to B1 inhomogeneity to resonance offset to their slice selective counterparts. Solutions have been obtained for tip angles from 150 to 900 in increments of 150. These rectangular composite pulse sequences were then used as the basis for frequency selective pulses with immunity to both B1 inhomogeneity and resonance offset.

2654. A Bandwidth-Modulated Adiabatic RF Pulse for Highly Selective Saturation and Inversion (BASSI)
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Applications such as outer volume suppression or pulsed arterial spin labeling require RF inversion and saturation pulses with extremely high spatial selectivity. We present here a bandwidth modulated adiabatic selective saturation and inversion RF pulse (BASSI). The corresponding amplitude modulation was derived from an analytical calibration equation for hyperbolic secant pulses. The current scheme compares favorably to previous approaches of gradient and frequency modulated RF pulses, in terms of spatial selectivity, homogeneity of the profile and pulse energy. Saturation and inversion profiles with a transition width of less than 0.7% of the slab thickness can be achieved.

2655. The Effect of RF Phase-Cycling on the T1 Contrast of the Brain
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The phase cycling of the excitation pulse in a spin echo sequence can have a subtle influence in T1 contrast. This occurs, as we explain, due to the presence of a low-level stimulated echo signal. Optimal T1 contrast is achieved when the excitation pulse phase is alternated between 0 and 180° on consecutive measurements. It is also shown that this effect creates perceivable White-Gray Matter contrast difference in brain imaging.

2656. Novel Technique for MR Phantom Manufacturing
Bryon Roos Gomberg¹, John Moshe Gomori¹
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MR phantoms are critical for longitudinal monitoring of scanner performance and multicenter studies. Creating realistic identical phantoms can be done using 3D plastic prototyping technology surrounded by gel from Objet Geometries Ltd. (Rehovot, Israel). We created several phantoms and scanned them on a 1.5 Tesla GE Sigma. Image SNR was high, and we were able to distinguish texture levels down to 0.4 mm. The technology shows strong potential to create realistic phantoms suitable for cross-site calibratin and longitudinal system monitoring.
2657. A Brain Phantom Composition for MR Applications Evaluation

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The phantoms used for everyday quality control may not be sufficient for MR application evaluation. For example, most brain phantoms reported in literature mimicked the T1 and T2 behavior of the white and gray matters. However, the importance of proton density is rarely emphasized. In this work, we demonstrated the possibility of designing a more realistic human brain gel phantom, and compared the results with human scans using T1-weighted images. It is further shown that using the phantom solutions described, it is possible to observe and optimize the flip-angle for maximum T1 contrast in T1-weighted sequences.

2658. Characterization of Spinal Canal Hydrodynamics and Compliance Using Bond Graph Technique and CSF Flow Measurements by MRI

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The spinal canal compartment plays an important role in regulating intracranial hydrodynamics and pressure. However, limited (and conflicting) information is provided in the literature concerning the overall spinal canal compliance and its distribution, as current methods are invasive and are associated with high risk of morbidity. They require injection of fluid into multiple locations along the spinal canal. The proposed method makes use of the naturally occurring oscillatory CSF flow during each cardiac cycle rather than external intervention. The method applies Bond Graph methodology to quantify spinal canal hydrodynamic properties. Results obtained in 4 healthy subjects are presented.

E-POSTERS: Steady State Free Precession Imaging

2659. Fat Saturation with Spectral Spatial Preparation Pulse for SSFP Sequences

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SSFP pulse sequences are clinically useful in every region. However, fat suppression feature is necessary for Abdominal Imaging. There are several techniques about fat suppression method for SSFP sequences, but each method has its advantage and disadvantage. We developed a new fat saturation approach based on spectral spatial preparation pulse (SPSP Prep). SPSP Prep suppresses fat tissues only in selected slice and don’t affect to others. The technique showed good fat suppression effect without any disadvantages. It also can be applied to 2D multi-shot multi-slice sequence or 2D Fast Spin Echo, so this technique will offer more advanced abdominal imaging.

2660. Imaging 3D Myocardial Motion with SSFP Cine DENSE

Elizabeth A. Cowart¹, Wesley D. Gilson¹, Christopher M. Kramer¹, Frederick H. Epstein¹
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In the present study we developed an SSFP cine DENSE sequence for measuring the three-dimensional motion of the heart. The accuracy of this technique was demonstrated using a rotating phantom and initial results in normal volunteers were validated versus similar measurements made by myocardial tagging.

2661. Real-Time Undersampled Radial IR-TrueFISP for Fast Quantitative T₁, T₂, & M₀ Mapping

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In this abstract, we use a real-time radially sampled IR-TrueFISP sequence with echo-sharing to map T1, T2 & proton density. These parameters were derived in a time comparable to the T1 times of interest (i.e. several seconds.) Retrospectively reconstructed T1-weighted, T2-weighted & FLAIR images showed good image quality, even though the acquisition time was only a fraction of the normal time. The use of these methods could revolutionize clinical exams, since the total acquisition time for a series of images with different contrasts would be on the order of a few minutes for a full 3D scan.

2662. Steady State Free Precessing Imaging with High Flip Angles at 3T

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An SSFP imaging technique with variable flip angles used to minimize SAR is presented. The flip angle is varied in phase encoding direction in k-space. Different variation schemes are analyzed and compared to constant flip angle imaging at identical total SAR. Experimental measurements of abdomen and head on healthy volunteers as well as on phantoms were performed at 3T. Image quality is not visibly affected by the variable flip angle scheme, although the PSF is expected to get somewhat broader. The SNR can be increased by 50% and more compared to a constant flip angle scheme at identical total SAR.
SSFP sequences with variable flip angles (such as TIDE) get more and more important in clinical MRI. Flip angle variations can be used during measurements for SAR reduction or contrast modification, and before data acquisition for magnetization preparation. This work presents a theoretical and experimental comparison between different flip angle variation functions used to minimize signal oscillation. Experimental measurements of phantoms and healthy volunteers were done on 1.5T. It can be shown, that with an adequate variation function signal oscillation and resulting image artifacts can be avoided. The optimum choice somewhat depends on the number of transition steps.

E-POSTERS: Dynamic Imaging

2664. Dynamic 4-Dimensional MRI of Knee Joint Movement Using FLASH 3D VIBE
Takashi Azuma¹, Yasuyuki Mizuno¹, Kentaro Iso¹, Jin Ito⁰, Yuuya Hiramoto², Masaya Nakamura¹, Manabu Katsuki¹, Yasuaki Nakagawa¹, Takashi Nakamura¹, Sadami Tsutsumi¹
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The purpose of this study was to develop a technique for dynamic 4-dimensional MR imaging of joint motion based on a combination of FLASH 3D VIBE imaging with surface radiofrequency coil. Using a closed-bore whole body MR scanner, dynamic 3-dimensional imagings of the knees were performed with changing the sequences. Addition to the basic technique of FLASH 3D VIBE, applying iPAT GRAPPA technique and regulating detail sequences made it possible to reduce the time required for imaging each whole volume data to 0.7 second with keeping appropriate qualities of image. This method enabled to take dynamic 4-dimensional images of joint motion.

2665. Diaphragm Alignment of Multiple Breath-Hold Dynamic Contrast-Enhanced MRI of the Liver for Quantitative Parameter Estimation
Mark James White¹, Simon Walker-Samuel¹, Erica Scurr¹, Adrian Tang¹, Martin O. Leach¹, David J. Collins¹
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Dynamic contrast-enhanced MRI of the liver suffers from practical challenges due to respiratory motion. Repeated short breath holds are used to obtain dynamic images at 13s intervals. Post-processing techniques similar to navigator methods are used to align the diaphragm boundary in successive frames. Compared to unaligned and manually aligned series, registered data demonstrate superior visualisation of small blood vessels and tumour heterogeneity in parametric (area-under-the-curve) maps. This simple, robust, and computationally inexpensive methodology allows characterisation of functional parameters in the liver with DCE-MRI.

2666. Free Breathing Radial Acquisitions of the Heart
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A method is presented for correcting respiratory motion in free-breathing cardiac acquisitions. Interleaved, undersampled images are acquired with navigator tracking in the through plane direction. These images are registered using a rigid registration algorithm and the data are corrected in k-space. A non-rigid registration algorithm determines deformation and the images are corrected in the image domain to give a motion corrected, fully sampled image. Rigid registration greatly improves the image quality in the region of the heart compared to images with no correction, deformation correction leads to further improvement in the heart and surrounding areas.

2667. Ultra High Spatio-Temporal Resolution 3D Dynamic MRI via Adaptive non-Fourier Encoding: Experimental Results
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Dynamic adaptive MRI via non-Fourier spatial encoding aims to increase the acquisition efficiency of a series of MR images while retaining image quality. This work presents two dynamic experiments using near-optimal encoding techniques that produce 3D frames at high temporal resolution over a large FOV at very high spatial resolution. In one experiment, a 16x16x27cm FOV is imaged at 0.625x.625x2.1mm resolution and 20sec temporal resolution. This represents a three-fold acceleration over a Fourier encoded stack of spirals, and 4.2 acceleration over ultra-short TR steady-state methods at equivalent spatial resolution.
Imaging of Freely Moving Objects by Means of Real-Time Image Coordinates Update Using an External Optical Motion Tracking System

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Subject motion appears to be a limiting factor in numerous imaging applications. Several navigator techniques have been proposed to circumvent the problem. Navigators, however, lengthen the measurement and perturb the steady state of the imaging method. Here the alternative approach, based on interfacing the scanner with an external optical motion tracking system, is demonstrated. The information on the object position measured optically is used to update the position of the imaging volume during the acquisition for each k-space line. This enables to suppress motion artefacts significantly without increasing the acquisition times even in the presence of large-scale motion.

Continuous Moving Table Whole-Body MRI on a 3T Magnet: Sequence Feasibility and Optimization (Preliminary Results)

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We report our preliminary experience with a new method for full-body MR imaging on a 3T magnet that employs continuous table motion and frequency-encoding along the z-axis. A total of 104 sets of coronal full-body images of 18 volunteers, using different parameter combinations, were analyzed and graded for different imaging criteria by an experienced abdominal radiologist. Sequence feasibility and best imaging parameters for GRE T1-weighted images are described.

Comparison of Stationary and Moving Surface Coil Setups for Continuously Moving Table MRI

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The use of surface coils for continuous whole body imaging is presented and compared for two different arrangements. The experimental setups consisted of an AngioSURF table, equipped with a homemade rf-shielded electrical drive, using surface coils held stationary relative to the magnet, and the original patient table of the scanner, equipped with a modified rf-shielded drive, using surface coils moving along with the table. T2-weighted axial images of the entire human body were acquired. Both setups showed similar image quality and no differences in signal-to-noise ratio. Advantages and drawbacks of both experimental approaches are discussed.

Adaptive Slice Shifting for Continuous Moving Table Acquisition Using hyperHASTE

Ute Ariane Ludwig¹, Maxime Zaitsev¹, Matthias Weigel¹, Gregor Sommer¹, Nadir Ghanem¹, Jürgen Hennig¹
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A method is described to adjust a HASTE sequence to the table speed for continuous whole body imaging. The modification is based on the adaptation of the slice position for each refocusing pulse within one echo train to the actual table motion. With the use of the adaptive slice shifting table speeds of more than 1cm/s can be chosen without any image artifacts due to faster table motion. The modified HASTE sequence provides regular T2-weighted images of the entire human body within short measurement times.

Selection of an Undersampling Pattern in the Phase-Encoded Plane

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It is possible to undersample the data in 3D high resolution MRA to reduce the scan times. The method presented here performs the undersampling in the phase-encoded (PE) plane. The samples are on the rectangular grid exactly. And different undersampling patterns are tested to find out the best distribution of data in the PE plane.

A Partial Fourier Reconstruction Method for Radially Acquired Data with Variable TE

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Lately, there has been an increasing interest in radial MRI due to its robustness to motion and the possibility of using partial k-space data to manipulate contrast. Radial fast spin-echo or radial gradient and spin-echo methods are used to speed acquisition as well as for obtaining images with variable T2-weighted contrast from a k-space data set. The acquisition speed of these methods can be further improved if data collection is based on the acquisition of half radial views. In this work, a half Fourier radial method to reconstruct images from half radial views acquired with variable T2 weighting is presented.
2674. **Algebraic Reconstruction for Parallel Imaging with Radial Trajectory**  
*Peng Qu*, Bing *Wu*, Gary X. *Shen*  
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A novel algebraic reconstruction method for parallel imaging with radial trajectory is proposed. Taking advantage of projection-slice theorem, the reconstruction can be performed by first carrying out a 1-D FFT and then iteratively solving a system of linear equations. Since the data in non-Cartesian coordinate are directly used, the bulk work of gridding is not required. The feasibility of this method was demonstrated by simulation.

2675. **Precalculated Iterative Next Neighbor re-Gridding (PINNG): Accurate and Efficient Reconstruction for Non-Uniformly Sampled K-space Data**  
*Hisamoto Moriguchi*, Jeffrey L. *Duerk*  
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The Iterative Next Neighbor Re-Gridding (INNG) algorithm is a quite accurate reconstruction algorithm for non-uniformly sampled k-space data. One primary disadvantage of the INNG algorithm is that it requires a number of 2D-FFTs, and the whole algorithm has to be started after data acquisition. In this study, a new method is presented to efficiently implement the INNG algorithm. In this algorithm, most of the computations can be performed before k-space data acquisition. The quality of the image reconstructed using this algorithm is comparable to that of the original INNG algorithm. The newly proposed method considerably facilitates reconstruction after data acquisition.

2676. **Scan Time Reduction with Gradient Energy Minimization (GEM) and Projection onto Convex Sets (POCS)**  
*Zheng Chang*, Qing-San *Xiang*  
1University of British Columbia, Vancouver, British Columbia, Canada

A fast imaging strategy for partial k-space reconstruction is presented which combines deghosting by Gradient Energy Minimization (GEM) and a modified Projection on Convex Sets (POCS) algorithm. The k-space is divided into low and high spatial frequency parts. The former part is fully sampled. The latter part is sampled with skipped steps leading to two ghosted edge maps after 2DFT, which are deghosted with GEM and used in a POCS algorithm as an initial guess. Repeated application of POCS yields a final image without noticeable artifacts. The feasibility of the GEM-POCS method has been demonstrated with 2D experimental data.

2677. **Comparison of the Chirp z-Transform and Interpolation Techniques for Field-of-View Scaling**  
*Joachim Bernhard Kaffanke*, Thomas *Dierkes*, Nadim Jon *Shah*  
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A version of a chirp z-transform [1] was programmed enabling phase-preserving FOV scaling for data sets with the zero of k-space in the middle. The method is important for all single-point imaging (SPI) sequences [2,3] such as SPRITE when used with multiple data acquisition for T2* mapping or signal averaging [4]. The method is most desirable for nuclei with short relaxation times like sodium at high field. Here, the chirp z-transform is compared with a conventional interpolation approach following fast Fourier transformation.

2678. **Reducing Spurious Minima in Automatic Off-Resonance Correction for Spiral Imaging**  
*Daeho Lee*, Krishna S. *Nayak*, John M. *Pauly*  
1Stanford University, Stanford, California, USA; 2University of Southern California, Los Angeles, California, USA

Automatic off-resonance correction can be an effective deblurring method when short scan time is desirable because it doesn’t involve an extra acquisition for the field map or estimation error from it. Large off-resonant phase accrual from a long readout time or wide off-resonance frequency range can lead to wrong estimation of a field map due to spurious minima. Multistage field map estimation was suggested to reduce this problem. We present here an improved approach for reducing the spurious minima by modifying the low-resolution field map estimation and the objective function used as a measure of off-resonance.

2679. **Synthetic Aperture MRI**  
*Gregory Stuart Mayer*, Michel Louis *Lauzon*, Hongmei *Zhu*, Ross *Mitchell*  
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Synthetic aperture MRI (SAMRI) is based on the principle that repeated imaging with known sub-pixel shifts of the field-of-view (FOV), combined with novel image reconstruction techniques can increase the spatial resolution or to improve the SNR. To implement SAMRI, multiple low-resolution images are obtained while shifting the FOV by distances with sub-pixel shifts between acquisitions. A synthesized high-resolution image is then obtained from the low-resolution images using a standard deconvolution algorithm. This formalism, based upon synthetic aperture and super-resolution imaging principles, can be used to obtain a higher image quality.
Novel prior-information-driven method is proposed for reconstruction of Dynamic MRI with under-sampled K-space. Not like keyhole based methods, this method uses both prior intensity information and prior K-space data. A full (satisfy Nyquist limit) K-space pre-scan is taken to get a high-quality image and choose the static area of the reconstructed image as prior background information. By taking advantage of similarity of background of dynamic image, the proposed method iteratively calibrates the sparse K-space data according to the prior background information and results in a full K-space. Numerical studies show the advantage of the proposed method.

The purpose of this study is to assess the feasibility and clinical utility of extended field-of-view imaging with table translation and frequency sweeping or frequency-adapted sliding table acquisition (FASTA). Five patients suspected of having systemic or multifocal lesions were tested with FASTA imaging. FASTA can provide coronal and sagittal head-to-toe image in about 8 min. In terms of detecting bone lesions, comparable information to bone scintigram was obtained Brain and hepatic metastases beyond the size of 1cm and 2cm, respectively, were detected; however, smaller lesions were not detectable. Lung lesions were also not detectable except for one Pancoast tumor.

E-POSTERS: Reconstruction: Fat-Water in Rapid Imaging

Steady State Free Precession provides strong signal, high contrast images in a short scanning time. However, strong fat signal contaminates image. This paper is to separate fat signal by applying single point fat water separation method.

In the recently proposed Spiral Dixon techniques, spatial-spectral pulses are not required in data acquisition and unambiguous water-fat separation can be achieved even in the presence of B0 inhomogeneities. Although the Spiral Dixon techniques offer reduced acquisition time compared with the conventional spiral data acquisitions, it would be desirable to further reduce acquisition time of the Spiral Dixon techniques since shorter acquisition time reduces motion artifacts as well as motion dependent misregistration among the data sets. In this study, it is shown that sensitivity encoding can be advantageously used in the Spiral Dixon techniques to facilitate the data acquisition.

True water-fat separation is achieved by phase-cycled SSFP and the single quadrature Dixon method. By using a combinatory signal constructed from the isolated SSFP echo signals, field inhomogeneity map is generated without the interference from chemical-shift. Water and fat images are constructed after phase correction from the isolated SSFP signals with elimination of the banding artifacts.

E-POSTERS: Lipid Measurements and Chemical Shift Correction

The Dixon technique is mostly known as an alternative to frequency selective and inversion recovery techniques for fat suppression. The three-point Dixon technique was developed to overcome the sensitivity to field inhomogeneity. Although these methods were originally devised for fat-suppression, they also can be used to measure the amount of fat in a tissue, specifically the fat content within the liver or the skeletal muscles. In this study we investigated the repeatability, reproducibility, and accuracy of the three-Point Dixon sequence in estimating true fat volume ratios using a fat-water phantom.
**2686. Implementation and Noise Analysis of Chemical Shift Correction for Fast Spin Echo Dixon Imaging**
Huanzhou Yu1, Scott B. Reeder1, Ann Shimakawa2, Garry E. Gold2, Norbert J. Pelc2, Jean H. Brittain2
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Chemical shift displacement artifacts in Fourier Transform MRI are well understood. The effect is mainly seen at the boundary between water and fat tissues due to the shift of fat in the read-out direction. The artifact can complicate image. We remove the displacement artifact by combining separated water images and shift corrected fat images. For the FSE Dixon water-fat separation acquisition, the artifact-free combined images are a potentially important side benefit. Noise analysis of such combination shows that the combined images have approximately effective NSA of 1.6, and about 30% SNR loss compared to the separated images.

**2687. A Fast Spiral Two-Point Dixon (Spiral 2PD) Technique Using Block Regional Off-Resonance Correction (BRORC)**
Hisamoto Moriguchi1, Jonathan S. Lewin1, Jeffrey L. Duerk1
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In the recently proposed Spiral two-point Dixon (Spiral 2PD) technique, a number of predetermined off-resonance frequencies must be tested to unambiguously separate water and fat signals and to de-blur the decomposed signals. Hence, the original algorithm is very computationally intensive. The block regional off-resonance correction (BRORC) algorithm has proven to be computationally quite efficient. This study shows that water-fat decomposition and blurring artifact correction can be performed using algorithms similar to BRORC and that this new technique (BRORC-Spiral2PD technique) significantly improves the computational efficiency of earlier Spiral 2PD algorithm and provides new opportunities for near-real-time imaging.

**E-POSTERS: Catheter Tracking and Cardiovascular Intervention**

**2688. Catheter Tracking and Visualization Using Perfluorocarbons in Interactive MR Fluoroscopy**
Sebastian Kozerke1, Sanjeeet Hegde2, Tobias Schaeffter1, Rolf Lamerichs3, Reza Razavi4, Derek L G Hill2
1ETH and University Zurich, Zurich, Switzerland; 2Guy's Hospital and King's College London, London, UK; 3Philips Research Laboratories, Hamburg, Germany; 4Philips Medical Systems, Best, Netherlands

To overcome existing limitations of active and passive catheter tracking techniques, exclusive device delineation and real-time tracking using perfluorocarbons is proposed. Two modes of operation are demonstrated. Firstly, 19F catheter tracking is interleaved into 1H fluoroscopy to provide real-time tip tracking of a standard catheter filled with the blood substitute perfluorooctylbromide. Secondly, exclusive visualization of the entire catheter length is achieved using SSFP imaging at the 19F resonance only. The proposed techniques present a promising alternative to existing visualisation methods allowing the use of standard catheter equipment together with an exogenous biocompatible contrast agent.

**2689. Marking Technique for ‘Bamboo’ Tracking Catheter in MR Guided Intervention**
Etsuko Kumamoto1, Kimitsuho Ono2, Kazuo Saito2, Yuichiro Matsuoka1, Bilgin Keserci1, Hisashi Abe1, Kagayaki Kuroda1, Yousuke Matsuo1, Hiroshi Mitsuhashi2, Susumu Fujii1
1Kobe University, Kobe, Hyogo, Japan; 2Bando Chemical Industries Ltd., Kobe, Hyogo, Japan; 3Institute of Biomedical Research and Innovation, Kobe, Hyogo, Japan; 4GE Yokogawa Medical Systems Ltd., Hino, Tokyo, Japan; 5Osaka University, Suita, Osaka, Japan

We have developed a novel catheter visualization technique called ‘bamboo catheter,’ which utilizes a periodical dark-bright pattern suitable for filtering out from the tissue signal in k-space. Various marking techniques for the bamboo catheter were examined. It was experimentally demonstrated that a novel polymer-absorbed Gadolinium complex for coating catheter had 219 % of contrast effect. An electronic active marking technique with a very small aperture (1.2 mm in diameter) RF receiver coil or DC current coil also exhibited clear bamboo patterns in the phantoms. In combination with our stereoscopic projection technique, the bamboo catheter was capable of 3D catheter tracking.

**2690. Catheter Tracking with Phase Information**
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Many invasive cardiovascular procedures such as traversing total chronic occlusions and myocardial stem cell delivery would benefit from using MR guidance by exploiting MRI’s excellent soft tissue contrast. In this study, we explore the possibility of using phase patterns in the MR signal around a small circular micro coil to determine its position and orientation. A localization scheme suited for real-time applications is developed through theoretical development and simulations of phase pattern sensitivity. Feasibility is demonstrated through experimental measurements of phase patterns around a micro coil in phantoms.
An ideal contrast agent for hybrid x-ray/MR systems should provide simultaneous contrast in both modalities. We have studied the relaxivity properties of iodine and gadolinium to develop a solution that may serve this purpose. The relaxivity ratio $R1/R2$ for Gd and iodine in saline was 0.94 and 0.24 respectively. For iodine with 0.1% Gd, this ratio increased to ~0.68 for all iodine concentrations. For changing Gd-contrast concentrations with 50% iodine, the ratio remained unchanged (0.94) from Gd in saline alone. These results indicate that iodine concentration should be minimized; therefore tradeoff between x-ray attenuation and MR contrast is required.

**2692. TIPS using Truly Hybrid X-Ray/MR Guidance**

Rebecca Fahrig1, Stephen T. Kee1, Bruce L. Daniel1, Arundhuti Ganguly1, Zhifei Wen1, Kim Butts1, Michael D. Dake2, Norbert J. Pelc1

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Transjugular intrahepatic portosystemic shunt placement (through liver from hepatic vein to portal vein (PV)) is challenging since the PV cannot be punctured directly; the vein must be accessed by traversing the liver. Image guidance could improve using a hybrid x-ray/MR system, with MR to guide the puncture and x-ray for catheter and stent placement. Preliminary patient results (12 patients, static anode/flat panel x-ray system in a Sigma 0.5T interventional magnet) indicate that number of punctures is reduced, and total examination time does not increase using hybrid guidance. Quickly switching between imaging modalities occurred up to 8 times per procedure.

**2693. Initial Clinical Experience with a Hybrid Interventional Angio-MRI System**

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We developed a hybrid interventional angio-MRI system, which consists of a 0.3-T open MR unit and a mobile x-ray C-arm, and applied this system to vascular interventional procedures. We performed percutaneous sclerotherapies, intraarterial infusion chemotherapies, and transcatheter arterial embolizations under MR and x-ray guidance. All procedures were successfully completed, and we were able to take the advantages of both modalities with this system. This system may be a helpful tool for MR-guided vascular intervention.

**2694. Real-Time MRI Guided Neurovascular Intervention**

John Pile-Spellman1, Lei Feng1, Erwin Lin1, Gaurav Gupta1, StephenDashnaw1, Hui Zhang1, Rahmi Oklu1, Michael Baytion1, Tom Kim1, Charles Dumoulin1

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Real-time MRI-guided neurovascular intervention offers the advantages of continuous monitoring of brain perfusion, tissue injury and neural activity, and no radiation to the patient or the operator. We carried out a pilot animal study to assess the feasibility of interventional neurovascular procedures under real-time MRI guidance. The carotid arteries were catheterized using active MR-tracking in 10 pigs. Carotid stenting, therapeutic occlusion, and intraarterial thrombolysis were successfully performed in these vessels without the use of any x-ray equipment. With the development of MR-tracking devices it will be possible to perform these interventional neurovascular procedures in patients under real-time MRI guidance.


Shaoxiong Zhang1, Shervin Rafie1, Tiping Chen1, Claudia Hillenbrand1, Jeffrey L. Duerk1, Jonathan S. Lewin1

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The feasibility of cardiac and coronary catheterization under MR guidance using only the native susceptibility of a standard X-ray angiographic catheter remains unclear. To test this, cardiac and coronary catheterization were performed on 8 pigs under real-time MRI guidance using conventional angiographic catheters and a passive tracking strategy. Cardiac catheterizations of both the right and left heart were successfully performed in all 8 pigs with an average procedure time of one minute from groin to each target region. In addition, right coronary artery catheterization was successfully completed in 4 of 5 pigs attempted with procedure times ranging from 30-90 minutes.

**2696. MRI Guidance and Monitoring of Injected Therapeutic Agents**

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In this study, a series of intraprostatic injections were performed using a transrectal system that allows for accurate MR-guided needle placement concurrent with imaging in a standard, 1.5T MR scanner. Eleven intraprostatic injections were performed in-vivo in canines; one injection was performed in an excised human cadaveric prostate. Without MR guidance, injection patterns can be difficult to predict and tissue structure is shown to have a very strong impact on injection distribution patterns. MR visualization of injected agents may allow for prediction and monitoring of drug distributions, improving efficacy and reducing treatment side effects.
E-POSTERS: Thermotherapy Assessment

2697. Controlled Apnea for Focused Ultrasound Ablation of Liver Tissue – Animal Model

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MR guided Focused Ultrasound Surgery (MRgFUS) presents a non invasive treatment option for liver tumors. However, liver motion during the respiratory cycle causes defocusing of the energy, difficulty in achieving a continuous treatment region, and prevents MR thermal imaging. Mechanical ventilation with intermittent apnea periods was tested on pigs under general anesthesia. Imaging and pathology results show that focused ultrasound can be delivered in a very accurate manner (<1mm), under thermal imaging monitoring, to create a continuous ablated lesion. Our experiment indicates that MRgFUS could become a safe and accurate non-invasive method for the ablation of liver tissue.

2698. Self-Referenced Temperature Imaging Based on Complex Image Estimation and Target Tracking Slab

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A ‘self-referenced’ temperature mapping method based on the ‘target-tracking-slab’ and complex-field-fitting techniques for estimating the temperature change distribution in liver was proposed. Results of the tissue, animal and volunteer experiments demonstrated that the proposed method consistently seized the heated region in the organ unlike the conventional temperature mapping strategies using a fixed slice slab. By virtue of complex field fitting, the proposed method reduced the estimation error for, in maximum, 85 % compared with the similar method using phase field fitting, whose accuracy was significantly spoiled by the phase gap exists in the region of interest.

2699. Three Dimensional MR Guided Temperature Imaging Feedback System for Microwave Liver Ablations in an Open MRI

Bilgin Muhammed Keserci¹, Daisuke Asami², Yosuke Yamamoto³, Daiki Kokuryo⁴, Azzam Anwar Khanak⁴, Daiki Harada⁵, Eisuko Kumamoto⁵, Kagayaki Kuroda⁶
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A dedicated PC-temperature imaging feedback system for guiding and assisting the microwave liver ablations in an open MRI was proposed. This system has quasi-real time feedback capability based on a newly developed ‘self-referenced’ based temperature imaging technique with on-line monitoring of respiratory profile. The 3D method uses the sequential acquisition of three orthogonal/arbitrary planes to seize the volume distribution of both temperature and thermal dose inside the target region. The proposed system may allow clinicians to control MR-guided microwave liver ablation procedures accurately.

2700. Optimization of Complex Field Estimation in the Self-Reference Temperature Imaging Method

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Optimization of the “self-reference” temperature imaging method with complex-field-fitting was examined experimentally with healthy human volunteer livers receiving no heat. When $2\pi$ phase jump(s) existed in an ROI, the error of this particular method turned out to be less than 10 % of the conventional method using a separate reference image, and to be 15 – 56 % of the similar self-referenced method with direct phase-field-fitting. It was also demonstrated that the area surrounding the ROI for the complex-field estimation should be 1.5 times larger than the ROI but not be attached to the organ edge.

2701. In Vivo Porcine Liver Radiofrequency (RF) Ablation with Simultaneous Temperature Monitoring

Karl Vigen¹, Joan Frisoli¹, Viola Rieke¹, Bruce Daniel¹, Kim Butts¹
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Proton resonance frequency (PRF) shift temperature mapping was performed concurrently with radio-frequency (RF) ablation using a modified RF generator that allows MR imaging without RF interference. Temperature maps were acquired that demonstrate the extent of heating in porcine liver in vivo.

2702. Phase-Shift Based Magnetic Resonance Thermometry during Motion

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Currently, phase-shift MR thermometry is limited by its sensitivity to motion. Here we suggest the use of an unipolar echoplanar acquisition to overcome this problem. In vitro calibration experiments show that unipolar echoplanar imaging provides accurate temperature measurements over a temperature range from 40-70 °C. Imaging the temperature evolution in a moving phantom and porcine liver experiments show that temperature measurement during motion is feasible using this approach.
E-POSTERS: Longitudinal Relaxation and Cross-Relaxation

2703. A Simple Correction for B1 Inhomogeneities in MTR Measurements
Rebecca Sara Samson1, Claudia A. M. Wheeler-Kingshott1, Dan J. Tozer1, Paul S. Tofts1
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The MTR dependence of B1 was modelled, and normalized graphs produced. For B1 reductions up to 20%, the plots for different brain tissue types could be approximated to a single line, fitting $\Delta \text{MTR} = 1.098 \Delta B1 - 0.095$. Thus, theoretically, a systematic B1 correction could be applied to MTR measurements, regardless of tissue type. On the scanner, B1 was reduced from its nominal value and MTR measured. The theoretical correction was applied, and reduced the errors in MTR to 0.2pu, better than the 95% confidence limit determined from repeated measurements. B1 mapping was used to quantify B1 errors and correct MTR maps and histograms.

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It is difficult to investigate white matter integrity in the spinal cord. Confounding factors are its small diameter, its proximity to surrounding bone and CSF, and a high degree of mobility. We propose to visualize spinal cord white matter using Global Magnetization Transfer (GMT) imaging, a method in which MT images are acquired over a wide range of off-resonance frequencies and CSF is used as reference. By determining the integral over the z-spectrum, data can be analyzed in a model-free approach. High-resolution axial GMT images were acquired in ten subjects, and good contrast between gray and white matter was achieved.

2705. Magnetization Transfer Imaging of Brain: A Quantitative Results Obtained At 3.0T
Yongmin Chang1, Moon-Jung Hwang1, Young-Joo Lee1, Sung-Jin Bae1, Sung-Gu Woo2, Hee-Jung Lee2
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Magnetization transfer (MT) effect is known to be more pronounced at the higher field and a quantitative comparison was made at 1.5T and 4.0T. However, the quantitative data of MT effect at 3.0T has not been available. In this study, we investigate MT effect of the brain at 3.0T and evaluate the off-resonance frequency dependence of the MT phenomenon.

2706. Proton Signal Characterisation in White Matter: A Four Pool Model
Thorarin A. Bjarnason1, Irene M. Vavasour1, Charmaine LL Chia1, Alex L. MacKay1
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Three signals were measured using an NMR spectrometer capable of differentiating between aqueous and non-aqueous signals. This data was fit using a four pool model which included two tissue and two water proton pools. The goal of this study was to attain a better understanding of the extent that these four pools communicate with each other, which could improve methods for measuring myelin content and to better assess the feasibility of using the myelin water portion as a measure of myelin content.

2707. Cross-Regularised Relaxographic Imaging
Christian Labadie1, Silvia Jarchow2
1Friedrich-Schiller-Universität Jena, Jena, Germany; 2Universität Bremen, Bremen, Germany

A novel cross-regularization of relaxographic imaging provides an increased resolution of the continuous distribution of longitudinal relaxation times with a doped phantom. The shape of the transversal relaxation peaks was investigated in the context of pig knee cartilage in various angles to the static field and subjected to a small pressure of 50 kPa. The cross-regularization was able to display peak features that are otherwise smoothed away by the general-purpose regularization.

2708. The Effect of Partial Volume on the Calculation of the Magnetisation Transfer Ratio (MTR)
Mark Symms1, Philip Boulby1, Gareth Barker2
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A theory is presented to model the effects of partial volume of brain with CSF for the estimation of MTR. It is shown that almost all MTR sequences will underestimate MTR as the proportion of CSF in a voxel increases. It is shown how to characterise any sequence to predict its sensitivity to partial volume effects.
2709. **A Method for Reduced SAR T₁ρ-Weighted MRI**  
Andrew James Wheaton¹, Arijitt Borthakur², Matthew Corbo², Ravinder Reddy²  
¹University of Pennsylvania, Philadelphia, Pennsylvania, USA; ²Univ. of Pennsylvania, Philadelphia, Pennsylvania, USA

A reduced SAR version of a T₁ρ -weighted sequence was developed and tested on an in vivo mouse brain. In the reduced SAR sequence, full amplitude spin-lock pulses were applied to the central region of k-space where most signal energy exists while the high-frequency k-space received a low amplitude spin-lock pulse. Measurements of T₁ρ in the mouse brain indicate minimal change in T₁ρ -weighting in comparison to conventional T₁ρ sequences while substantially reducing SAR. The reduced SAR method can be exploited to safely shorten TR and/or extend the T₁ρ -weighted MRI technique to high-field imaging (B₀≥3T).

2710. **Use of a Composite Spin Lock Pulse for Background Suppression with Applications to Angiography and Perfusion Imaging**  
Greg Zaharchuk¹, Eric T. Hahn², Charles H. Cunningham³, David Saloner¹, Jean H. Brittain²  
¹University of California at San Francisco, San Francisco, California, USA; ²General Electric Medical Systems, Menlo Park, California, USA; ³Stanford University, Stanford, California, USA

This abstract describes the use of a long, composite spin locking pulse for background suppression, with applications to TOF angiography and perfusion imaging. It exploits the fact that no longitudinal regrowth of magnetization occurs while spins are locked. Composite ±360 pulses were effective in maintaining uniform magnetization of spins outside the locked region. Initial experiments suggest that on-resonance magnetization transfer (which is small for blood) plays the major role in decreasing their equilibrium magnetization. We demonstrate the efficacy of background suppression and present images of the human brain vasculature obtained with this method.

2711. **Visualizing Distant Dipolar Field and Intermolecular Multiple Quantum Coherence Sequences**  
Curtis Andrew Corum¹, Arthur F. Gmitro¹  
¹University of Arizona, Tucson, Arizona, USA

Sequences utilizing the distant dipolar field (DDF) or intermolecular multiple quantum coherences (iMQCs) have been investigated for over 20 years. While elegant derivations involving the density matrix or classical electromagnetism combined with Fourier analysis are available, they are not accessible if one does not have an extensive physics or mathematics background. A set of animations based on the equations of Deville et al. has been developed to show more intuitively the properties of DDF/iMQC sequences. These animations have proven effective in presentations to explain DDF/iMQC sequences such as CRAZED to those with an intuitive understanding of the vector Bloch model.

2712. **R₁ρ Dispersion in Rat Brain during Global Ischaemia and Gene Therapy of an Experimental Glioma**  
Mikko I. Kettunen¹, Johanna Silvennoinen¹, Timo Liimatainen¹, Olli H.J. Gröhn¹, Juhana Hakumäki¹, Risto A. Kauppinen²  
¹University of Kuopio, Kuopio, Finland; ²University of Manchester, Manchester, UK

R₁ρ dispersion (0.01-6.0G) was measured in normoxic and ischaemic rat brain as well as during gene therapy of an experimental glioma at 4.7T. In ischaemia, maximal alterations in dispersion were observed at a B₁ field range from 0.2 to 2G. During gene therapy, the entire dispersion curve shifted and alterations in its shape were also observed. This suggests for differential relaxation mechanisms in acutely ischaemic brain and gene therapy -induced cell death. Furthermore, R₁ρ dispersion in ischaemia may be a more sensitive marker of pathological condition as compared to single-B₁ experiment while the same may not be true in gliomas.

2713. **A New Method for the Quantitative Measurement of Localised Absolute Water Content using MRI**  
Heiko Neeb¹, Thomas Dierkes¹, Nadim J. Shah¹  
¹Forschungszentrum Juelich GmbH, Juelich, Germany

A clinically relevant method for measuring absolute water content with MRI is presented. The method was validated on phantom measurements and showed excellent agreement (<1.5%). An in vivo experiment with an acquisition time of about 15 minutes was performed, demonstrating quantitative water maps in clinically-relevant measurement times. The applications of this method to clinical studies are manifold.
E-POSTERS: ESR Imaging

2714. Proton Electron Double Resonance Imaging Enables Real-Time Mapping of Risk Region and Necrosis in the Postischemic Heart
Haihong Li1, Xue Zhao1, Sergey Petryakov1, Yuanmu Deng1, Giuseppe Colantuono1, Ziqi Sun1, Periannan Kuppusamy1, Jay L. Zweier1
1The Ohio State University College of Medicine, Columbus, Ohio, USA

Proton Electron Double Resonance Imaging (PEDRI) images were acquired on isolated beating rat hearts (N=18) before and after the onset of regional ischemia (30 ~ 60 min) and during the followed reperfusion (90 ~ 120 min) procedure inside an improved-design EPR-NMR double resonator. Nitroxide Tempone was used as spin probe. Heart ischemia area was clearly mapped by 3D images. By studying and comparing the unique information obtained regarding the time course of changes in redox metabolism of the risk region with normal myocardium, the risk and necrosis area were evaluated and mapped in real time. Histology method was also performed.

2715. Time-Domain Spectral Spatial RF EPR Imaging
Sankaran Subramanian1, Ken-Ichiro Matsumoto1, Thirumaran Aravallavan1, Nallathamby Devasahayam1, Ramachandran Murugesan1, John A. Cook1, James B. Mitchell1, Murali Krishna Cherukuri1
1National Institutes of Health, Bethesda, Maryland, USA

Single Point or Constant Time imaging (SPI or CTI) technique, which is a pure phase-encoding methodology, leads to images of superior quality, compared to filtered back projection, in time domain EPR imaging [1]. This is because the image processed from a single time point after a specific delay from the pulse has no spectral information. However, the line width information manifested through the T2* can be evaluated from a series of sequential single point images generated from the same experiment. EPR imaging in the SPI modality can provide images of pO2 distribution in vivo in a quantitative manner.

2716. Fast EPR Imaging Using Spinning Magnetic Field Gradient
Yuanmu Deng1, Guanglong He1, Sergey Petryakov1, Periannan Kuppusamy1, Jay L. Zweier1
1The Ohio State University, Columbus, Ohio, USA

We report the development of a fast low-frequency electron paramagnetic resonance imaging (EPRI) system using spinning magnetic field gradient. Based on a 300 MHz conventional EPRI system, we have built a 2D fast imaging system, which is capable of acquiring a 2D image in about 20 s with reasonable image quality. This is 2-4 times faster than regular EPRI acquisition.

2717. Development and Initial Results with the First Specifically Built Clinical EPR Spectrometer
Harold M. Swartz1, Tadeusz M. Walczak1, Piotr N. Lesniewski1, Ildar Kh. Salikhov1, Oleg Y. Grinberg1, Akinori Iwasaki1, Patrick A. Hein1, Richard J. Comi1, Jay C. Buckey1, Eugen B. Hug1, David A. Schauer2
1Dartmouth Medical School, Hanover, New Hampshire, USA; 2Uniformed Servicces University of the Health Sciences, Bethesda, Maryland, USA

We describe the initial steps and results of the first specifically developed clinical EPR facility. It uses a large permanent magnet, with a working volume equivalent to that of a clinical MRI. The initial clinical studies especially use the unique capabilities of EPR to measure oxygen in tissues repeatedly and accurately, to follow the status of feet of diabetics at risk for peripheral vascular disease, in tumors to enhance radiation therapy, and in wound healing. It is being used to measure radiation dose “after-the-fact”, based on the induction of long-lived EPR spectra in teeth from exposures to ionizing radiation.

2718. Tailored Sinc Pulses for Uniform Excitation in RF EPR Imaging
Nallathamby Devasahayam1, Ramachandran Murugesan1, Ken-Ichiro Matsumoto1, James B. Mitchell1, John A. Cook1, Sankaran Subramanian1, Murali K. Cherukuri1
1National Institutes of Health, Bethesda, Maryland, USA

In time-domain EPR imaging, the large bandwidths of 10-12 MHz required for imaging a mouse even under nominal gradients of about 1G/cm, makes uniform excitation rather challenging, because of the sinc [sin(x)/x] profile of the power spectrum of a rectangular pulse. This situation is further compounded by the “Guassian droop” in the resonator response dictated by the quality factor. The use of tailored sinc shaped pulses with nanosecond time resolution with a single side lobe with optimally enhanced amplitude compensates for both the factors, leading to quantitative intensity information, necessary for evaluating in vivo pO2.
### E-POSTERS: Hyperpolarized Helium and Xenon

<table>
<thead>
<tr>
<th>Poster Session</th>
<th>Title</th>
<th>Authors</th>
<th>Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2719.</strong></td>
<td><strong>Investigation of Atherosclerotic Plaques by Hyperpolarized $^{129}$Xe</strong></td>
<td>Ivan Emilov Dimitrov¹, Natalia V. Listiza², Nick N. Kuzma³, Albert Chu³</td>
<td>¹University of Pennsylvania, Philadelphia, Pennsylvania, USA; ²Princeton University, Princeton, New Jersey, USA; ³Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, USA</td>
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Previously, Gd-enhanced MRI has been shown capable of characterizing atherosclerotic plaque composition. Here, we investigate a new avenue for plaque characterization, whereas the extreme sensitivity of $^{129}$Xe to its environment is used to delineate tissues based on their composition. Studying excised human aortas, we report that in the diseased tissue the dissolved hyperpolarized $^{129}$Xe peak is significantly broader than in normal tissue and it has a non-resolved feature at about 200 ppm. The position of this feature, which is missing in normal tissue spectra, indicates that it is likely associated with Xe dissolved in the fat core of the plaque.

| **2720.**      | **Hyperpolarized Helium-3 Lung Function Imaging in Ozone Exposure Experimental Models** | Yannick Crémillieux¹, Stéphane Servais², Yves Berthezène², David Dupuich¹, Aurélien Boussouar⁰, Philippe Anfré¹, Vasile Stupar¹, Jean-Marc Pequignot⁰ | ¹Laboratoire de RMN, Villeurbanne, France; ²Laboratoire de Physiologie Intégrative Cellulaire et Moléculaire, Villeurbanne, France; ⁰CREATIS, Lyon, France |

The purpose of this study was to investigate the effects of acute and sub-acute ozone exposure on rats using hyperpolarized 3He ventilation imaging. Eighteen Sprague-Dawley rats, submitted to 0.5 ppm ozone concentration, were imaged. Dynamic ventilation acquisitions were performed and images series were analysed using the SPIRO technique. The helium MRI technique proved very sensitive for detecting ozone effects and large ventilation defects were observed for all animals exposed to ozone during 6 days.

| **2721.**      | **Passive Shimming of the Fringe Field of a Superconducting Magnet for Ultra-Low Field Imaging of Hyperpolarized $^{129}$Xe Gas** | Juan M. Parra Robles¹, Albert R. Cross³, Giles E. Santyr⁰ | ¹Carleton University, Ottawa, Ontario, Canada |

The fringe field of conventional superconducting magnets potentially can be used for hyperpolarized xenon gas imaging at ultra-low field strengths. In this work, a passive shimming method (that uses steel rods) is described and used to reduce the large inhomogeneities of the fringe field of a 1.89 T superconducting magnet to a level sufficient to obtaining images from xenon gas samples at 8.5 mT and 20 mT. This approach, which uses most of the hardware of a high field system, is an inexpensive and convenient way of expanding the low field capabilities of MRI facilities for hyperpolarized gas imaging.

| **2722.**      | **Comparison of 3D and 2D Gradient Echo for Human Lung Ventilation with Hyperpolarized $^3$He** | Jim M. Wild⁰, Neil Woodhouse¹, Zead Said¹, Martyn NJ Paley¹, Stan Fichele¹, Larry Kasuboski², Edwin JR van Beek¹ | ¹University of Sheffield, Sheffield, Yorkshire, UK; ²Philips Medical Systems, Cleveland, Ohio, USA |

In-vivo images of inhaled hyperpolarized 3He were acquired at breath-hold with a 3D gradient echo sequence. The images demonstrate favorable SNR and resolution compared to 2D methods, currently used for imaging ventilation. The in-vivo findings were substantiated with in-vitro experiments and simulations for both 2D and 3D. The increased SNR of 3D was most noticeable with thin slices where 2D images suffer from diffusion dephasing due to the strong slice gradient. The advantages of high resolution 3D acquisitions are highlighted with multi-planar reformatting of the 3D data and volume rendering of the gas volume in the lung.

| **2723.**      | **Simulating Helium-3 Diffusion in the Lung: Comparing the “Cylinder-Model” with Simulated 3D Alveolar Ducts** | Stan Fichele¹, Martyn N. Paley¹, Neil Woodhouse¹, Zead Said¹, Paul D. Griffiths¹, Edwin J.R. van Beek¹, Jim M. Wild⁰ | ¹University of Sheffield, Sheffield, UK |

Time-dependent measurements of 3He diffusion in the lungs could provide an accurate method to quantify disease. However, it is not fully understood and presents a complex problem to solve analytically. Here, finite difference methods have been used to simulate diffusion in 3D alveolar ducts. Our results are compared to a recent analytical model – which we call the “cylinder model” – where the average radii of the alveolar ducts can be determined from invivo data. The simulation results agree well with the “cylinder model”, however, the analytical model was found to overestimate the “effective” alveolar radius of the structures studied.
2724. **Influence of Lung Filling on T₂* Values in Human at 1.5 T with Hyperpolarised ³He**

Ludovic de Rochefort¹, Alexandre Vignaud¹, Xavier Maître¹, Geneviève Guillot¹, Luc Darrasse¹, Jacques Bittoun¹, Emmanuel Durand¹

¹Université Paris Sud, Le Kremlin-Bicêtre, France

This work shows T₂* measurements at 1.5T in human lungs using hyperpolarised ³He. The influence of lung filling was assessed by respiratory flow monitoring. It is concluded that T₂* correlates positively with alveolus size.

2725. **MRI and PET Imaging of Asthma-Like Reaction to a Segmental Ragweed Challenge in a Small Animal Model**

James H. Holmes¹, Ron L. Sorkness¹, Sara KK Melbom¹, Senthil Sundaram¹, Scott B. Perlman¹, Alexander K. Converse¹, Andrew D. Hahn¹, Robert W. Pyzalski¹, Frank R. Korosec¹, T M. Grisel¹, Sean B. Fain¹

¹University of Wisconsin-Madison, Madison, Wisconsin, USA

This work uses multimodality imaging to non-invasively observe the ventilation, inflammation, and metabolic components of the physiological response to asthma-like reactions in a small animal model. Imaging was performed pre and post segmental allergen challenge. MRI imaging of lung ventilation was performed using hyperpolarized Helium-3 and gated projection acquisition (PR). T1 weighted MRI was used to detect fluid buildup in the lungs and [F-18]FDG PET imaging was performed to determine metabolism. These methods successfully visualized and correlated the ventilation, inflammation, and glucose metabolism for a segmental asthma-like response in a small animal model and are confirmed by tissue evaluation.

**E-POSTERS: Tracking of Labeled (Stem) Cells**

2726. **In Vivo and In Vitro MR Imaging of Magnetically Labelled Human Embryonic Stem Cells**

Tommi Tallheden¹, Malin Lorentzon¹, Olivier Rakotonirainy¹, Bassam Soussi¹, Anders Lindahl¹, Finn Waagstein¹, Elmir Omerovic¹

¹Department of Clinical Chemistry and Transfusion Medicine, Gothenburg, Sweden; ²Wallenberg Laboratory, Gothenburg, Sweden

This study describes a method for effective magnetic labelling of human embryonic stem cells for in vivo and in vitro tracking with MRI.

2727. **In Vitro MR Assessment of Proliferating SPIO-Labeled Mouse Embryonic Stem Cells**

Takayasu Arai¹, Jeff W. M. Bulte², Micheal V. McConnell¹, Joan Marie Greve¹, Phillip C. Yang¹

¹Stanford University School of Medicine, Stanford, California, USA; ²Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

We conducted an in vitro investigation of proliferating SPIO-labeled mESCs by studying T2* and T1 effects of the mouse embryonic stem cells undergoing 4 cell divisions using fast GRE and inversion recovery-GRE (IR) sequences at 1.5 T and 4.7 T. We report 1) effect of multiple cell divisions on cell labeling, 2) quantitative correlation between the number of cells and magnetic signal intensity, and 3) signal detection at higher magnetic field.

2728. **High Resolution Imaging of Myocardial Infarction at 1.5T and 3.0T: Is it Possible to Track SPIO Labeled Cells?**

Piotr Alfred Wielopolski¹, Ewout Jan van den Bos¹, Zhuoli Zhang¹, Amber Moelker¹, Robert Jan van Geuns¹

¹Erasmus MC, Rotterdam, Netherlands

Delivery and tracking of cells in-vivo with MRI has a great potential. The introduction of bone marrow cells to restore damaged or dysfunctional myocardium to functionality has been proposed and validated to certain extent. Nonetheless, tracking these cells in vivo to correlate cell presence with positive outcomes in cardiac function is difficult non-invasively and without the use appropriate markers that are safe, visible, durable and non-genomic. We explore pig excised heart specimens using high-resolution 1.5T and 3.0T MRI to detect SPIO labeled bone marrow cells introduced after intra-coronary injection to the feeding coronary artery of a previously infarcted region.

2729. **Cellular Imaging of Tumor Infiltration by Lymphocytes Labeled with Superparamagnetic Particles : A Comparative Study at 7 and 9.4 T**

Pierre Smirnov¹, Élise Lavergne², Florence Gazeau², Bich-Thuy Duan³, Brigitte Gillet³, Christophe Combadière³, Olivier Clement³

¹Faculté de Médecine Necker, Paris, France; ²Hôpital Pitié-Salpêtrière, Paris, France; ³Boucicaut, Paris, France; ⁴ICSN CNRS, Gif sur Yvette, France

The aim of this study was the follow-up by MRI of lymphocyte infiltration in implanted tumors in mice. After magnetic and fluorescent labelling and injection, lymphocytes were detected in vivo by IRM 7T and ex vivo at 9,4 T at the level of the tumor. Tumor enhancements at 7T showed decreases depending on the time post injection and on the weighting sequence, showing the presence of labelled cells in the tumor. MRI at 9,4 T allowed to detect the distribution of labelled cells at a cellular resolution. Other ex vivo studies allowed to detect lymphocytes populations within the tumor.
2730. **Paramagnetic Labeling of Cells Using High Relaxivity Nanoparticles**

*Henry Bryant1, Samira Guccione1, Yantian Zhang1, Jianwu Xie1, Mark Bednarshi1, King Li1*

1National Institutes of Health, Bethesda, Maryland, USA

Magnetic labeling of cells allows for in vivo monitoring of cellular migration using MRI. Previously used cell labeling contrast agents included dendrimer-based gadolinium chelates, magnetodendrimers with iron coatings, superparamagnetic iron oxides with transfection agents and dextran-linked gadolinium chelates. We have investigated the first use of gadolinium incorporated into polymerized lipid-based nanoparticles (Gd-NP). We were able to detect by MRI intra-cellular Gd-NPs and cell distribution which are important considerations for in vivo tracking of dividing cells and for stem cell research.

2731. **In Vivo MR Evaluation of the Timing of Mouse Embryonic Stem Cell Transplantation at 4.7 T**

*Phillip C. Yang1, Anthony Caffarelli1, Takayasu Arai1, Joan Greve2, Jeff Bulle2, Theo Kofidis1, Thomas Quertermous1, Michael McConnell1, Robert Robbins1*

1Stanford University, Stanford, California, USA; 2Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

A longitudinal evaluation of myocardial viability and function (LVEF, LV mass, and LV volume) in mouse AMI model following mESC transplantation therapy at different time points using 4.7 T was conducted.

2732. **In Vivo Magnetic Resonance Imaging of Embryonic Stem Cells in Mouse Myocardial Infarction Model**

*Nathan Himes1, Jian Min1, Rebecca Lee1, Courtney Brown1, Jessica Shea2, Masaya Takahashi2, James Morgan1, Peter Oettgen2, Deborah Burstein2*

1Harvard-MIT Division of Health Sciences and Technology, Cambridge, Massachusetts, USA; 2Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA

Mouse embryonic stem cells were loaded with superparamagnetic iron oxide (Feridex) particles. Colocalization of staining on Prussian blue and DAPI of infarcted mouse hearts 24 hours post-injection demonstrated that the Feridex was localized to regions of the embryonic stem cells, demonstrating that cells maintained the particles in vivo. By MRI, a large susceptibility effect was observed in eight mice injected with Feridex labeled mouse embryonic stem cells; this susceptibility effect remained relatively consistent for over 5 weeks with a slight narrowing and elongation of the effect at the longer time points perhaps as a result of ventricular remodeling.

2733. **In Vivo Monitoring of Inflammatory Cell Mobilization to Heart Following Myocardial Infarction**

*Tom C-C Hu1, Weike Bao1, Stephen C. Lenhard1, Thomas R. Schaeffer1, Rosanna C. Mirabile1, Paula Jacobs2, Tian-Li Yue1, Robert N. Willette1, Beat M. Jucker1*

1GlaxoSmithKline, King of Prussia, Pennsylvania, USA; 2Advanced Magnetics, Inc, Cambridge, Massachusetts, USA

Ultrasmall Superparamagnetic Iron Oxide (USPIO) contrast agents have been used in conjunction with MRI to assess atherosclerotic plaque inflammation, track mesenchymal stem cells, and indicate organ rejection by labeled T-cells. In this study, we examined the potential for inflammatory cells pre-labeled with a USPIO agent (ferumoxytol) to home to the myocardial injury site following myocardial infarction (MI) in a rat model. The homing process was monitored using non-invasive cardiac MRI, ex-vivo MRI, and histology at 2.5 months post-MI. The co-localization of ferumoxytol with macrophages suggest that this technique may be used to monitor chronic inflammatory processes in the heart.

**E-POSTERS: Outcomes: Cost-Effectiveness and Economics**

2734. **Consortium of Multiple Sclerosis Centers (CMSC) Guidelines for a Standardized MRI Protocol for the Diagnosis and Followup of Multiple Sclerosis: Update and Implementation**

*David K.B. Li1, Anthony Traboulsee2, Donald W. Paty3, MR Work Group Consortium of MS Centers*

1University of British Columbia, Vancouver, British Columbia, Canada; 2CMSC, Teaneck, New Jersey, USA

A follow-up consensus meeting sponsored by the Consortium of MS Centres was convened to i) review and update proposed guidelines for a standardized brain and spinal cord MRI protocol in the diagnosis and follow-up of patients with suspected and established multiple sclerosis and ii) develop implementation strategies. The guidelines were developed with the aim of making them universally helpful, practical and acceptable. Implementation of these useful and useable guidelines for standardized MRI protocol in MS will benefit patients and be helpful to neurologists and radiologists.

2735. **Incidental Findings in MRA for Mesenteric Ischemia: Impact on Utilization**

*Robert Burman1, Ruth Carlos1, Qian Dong1, A. Mark Fendrick1*

1University of Michigan, Ann Arbor, Michigan, USA

Increasing use of MR angiography for mesenteric ischemia results in increased identification of “incidental findings” potentially necessitating further evaluation. We examined the impact of such incidental findings on downstream imaging utilization.
2736. **The Clinical and Economic Impact of the “Incidental Finding” after MR Angiography for Hypertension**  
*Ruth Carlos¹, Qian Dong¹, Christina Kiessel¹, David Jamadar¹, A. Mark Fendrick¹*  
¹University of Michigan, Ann Arbor, Michigan, USA

Overall utilization of MRA has dramatically increased from 1993-1998. In particular, use of MRA in the evaluation of hypertensive individuals has markedly increased. An advantage of MRA over other modalities (eg. nuclear scintigraphy, or even duplex doppler ultrasound), is the ability of MRA to detect the “incidental” lesions. Lesions, such as renal cell carcinoma or adrenal adenoma, that may alter clinical care. The frequency of such findings, and more importantly, the clinical and economic impact of such findings, is unknown. We present data estimating the clinical and economic impact of incidental findings on renal MRA.

2737. **Incorporating Patient-Centered Outcomes in Cost-Effectiveness Analysis of Imaging in Renal Artery Stenosis**  
*Ruth Carlos¹, David Axelrod¹, James Ellis¹, Paul Abrahamse¹, A. Mark Fendrick¹*  
¹University of Michigan, Ann Arbor, Michigan, USA

Previous economic analyses noted that MRA was not cost-effective in evaluating renal artery stenosis compared to CTA; however, quality of life components excluded from the analysis. We revisit the issue of cost-effectiveness of MRA compared to CTA and conventional angiography in individuals suspected of renovascular hypertension with emphasis on quality of life components.