Magnetic Resonance Imaging of Newborns and Premature Infants at 1.5T and 3T with an 8-Channel Phased Array Head Coil

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Introduction For a detailed understanding of diseases and developmental processes during the first year of live without harming the patient by using ionizing radiation, magnetic resonance imaging (MRI) of the neonatal brain is mandatory. So far this could be achieved by using an MR-safe incubator [1,2] with an integrated circular polarized birdcage coil. Because reduction of scan time (minimizing movement artifacts and specific absorption rate) is needed, phased array coils to apply parallel imaging techniques have to be developed. Since comparable field strength studies, for analyzing influences of image contrasts, may be performed; an 8-channel phased array head coil for use in an MR-safe incubator was designed and tested at 1.5T and 3T in this study.

Material and Methods Two identical 8-channel arrays were built (17mm diameter, 120 mm length), having square shaped receive elements of 86.5mm x 120mm (Figure 1). The elements were tuned and matched to 63.6MHz respectively 123.2MHz. Decoupling to other elements was achieved by critical overlap and preamplifier decoupling [3]. Because space is limited, the preamps were implemented in the receive loops. Resulting preamplifier oscillations were overcome by appropriate shielding and trapping of cable currents. Image evaluations were run on a Magnetom Trio TIM (Siemens Medical Solutions, Erlangen, Germany) with a spoiled gradient echo sequence (TR/ TE/ α = 100ms/10ms/25°): All in vivo images were acquired in an MR-safe incubator ("LMT nomag® IC", LMT Lammers Medical Technology GmbH, Lübeck, Germany) to minimize environmental stress of the patients. 1.5T in-vivo images were acquired at a Signa Excite (GE Healthcare, USA) and 3T in-vivo images at a Magnetom Verio (Siemens Medical Solutions, Erlangen, Germany).

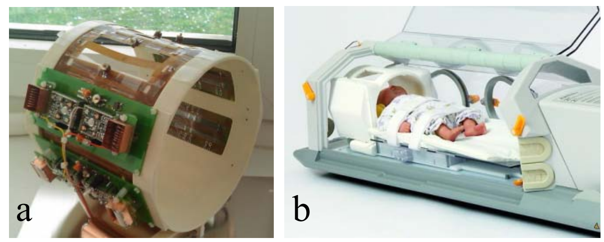

Figure 1: (a) Prototype of the 8-ch head array and (b) the final setup in the MR-safe incubator.

Results The noise correlation matrices show a very good decoupling in between the rx-elements (Figure 2). No coupling is higher than 40%.

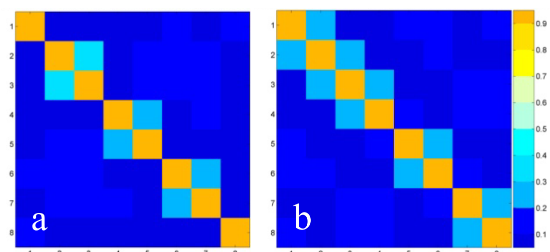

Figure 2: Noise correlation matrices of (a) the 1.5T and (b) the 3T head array.

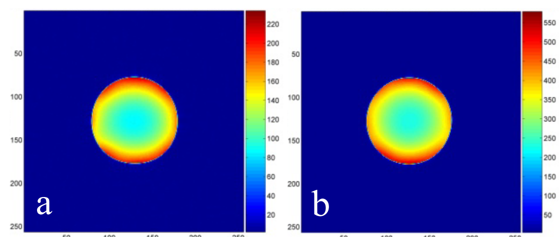

Figure 3: SNR maps of the (a) 1.5T and (b) 3T 8-channel head array coil. Because of the SNR increase, when imaging at higher field strength, the SNR scales were chosen to be different, to allow judgment of SNR homogeneity.

Tab 1: Comparison of center SNR values

	SNR_{center}/ $SNR_{1.5T\ 8ch}$	SNR_{center}/ $SNR_{3T\ 8ch}$
Siemens head matrix	0,69	0,75
Invivo 8ch-knee coil		0,99

SNR maps (Figure 3) show a good homogeneity profile with the typical SNR increase when going to higher field strength. Compared with similar shaped array coils the 8-ch head coil performs well (Tab 1). In vivo images (Figure 4) were obtained, while the patients were thermo regulated by the MR-safe incubator. All scans were performed with non sedated and free breathing patients.

Discussion This new combination of multi element phased array technology and a MR-safe incubator opens up new ways for diagnostics of premature infants and newborns. It provides improved SNR, maximum patient comfort, safety and the benefits of parallel imaging techniques, where scan times and SAR is being decreased by under sampling k-space. Especially the latest point should not be underestimated, as the patients are only very low weight (1-5kg) and a general issue is the fast reaching of SAR limits at 3T. The possibility to perform comparable field strength studies with identical array coils will help further evaluation of optimum imaging parameters.

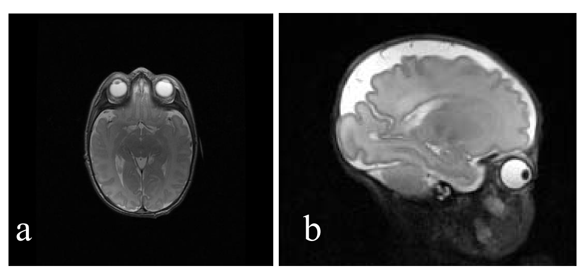

Figure 4: In-vivo images acquired with the 8-ch head array. (a) A 7 day old male newborn (Courtesy: Scientific Center of Obstetrics, Gynecology and Perinatology, Moscow) at 1.5T (2.5 x 2.5mm^2 x 3mm slice) and (b) a 1500g female premature infant in a 1.3 x 1.3 mm^2 x 3mm slice resolution (Courtesy: Institut für klinische Radiologie, Klinikum der Universität München) at 3T.

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