Non-CPMG multi-echo spin echo imaging with short echo times

M. Klarhöfer[1], J. Hirsch[2], A. Gass[2], K. Scheffler[1]

[1]MR-Physics, Department of Medical Radiology, University of Basel, Basel, Basel, Switzerland, [2]Department of Neuroradiology, University Hospital Basel, Basel, Switzerland

Introduction: Usually radial acquisition sequences with short excitation pulses are used to discriminate short T2 components in tissues [1]. These sequences allow ultrashort echo times below 100 µs. However, for some applications echo times of the order of a few milliseconds might be sufficient to identify short T2 components such as myelin water [2]. Purpose of the present work was to implement a multi-echo spin echo imaging sequence for the detection of tissue fractions having short T2 values.

Methods: The sequence was implemented on a Siemens Avanto system at a field strength of 1.5 Tesla. Maximal slew rate of the gradient system was 200 mT/m/s, a 12 element head coil was used for signal reception. 8 echoes were acquired after each excitation pulse, shortest echo time was 1.8 ms. Hard pulses were used for excitation and refocusing, they had durations of 200 and 400 µs and flip angles of 60 deg and 180 deg, respectively. Since the hard pulses prevented slice selection, 3D datasets of the human head were acquired. To eliminate folding artefacts, phase encoding was done in anterior-posterior and left-right directions, the readout direction was head-foot. To keep TE short, no spoiler gradients were applied around the first refocusing pulse. Instead, two acquisitions with opposite phase of the refocusing pulses were averaged. This leads to cancellation of the fid signal caused by the 180 deg pulse. Other imaging parameters were: TR=160ms, matrix: 192x96x32, spatial resolution: 1.3 x 2.6 x 5 mm3, parallel acquisition in anterior-posterior direction with a reduction factor of 2, GRAPPA reconstruction, acquisition time: 11 min. Preliminary experiments were performed on healthy volunteers.

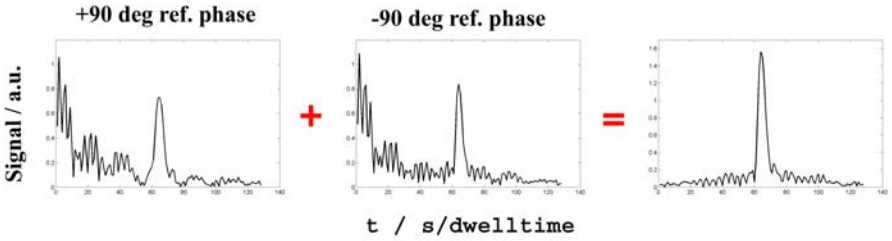

Fig. 1: Cancellation of FID contributions by signal averaging.

Results: Fig. 1 shows the cancellation of fid contributions by averaging of two echoes refocused with opposite polarity of the 180 deg pulse. In Fig. 2 eight echo images with echo times between 1.8 and 44 ms of one sagittal slice of the 3D dataset are shown. The first echo images exhibit a T1 contrast caused by the short repetition time of the spin echo sequence. Measured signal decay in white matter and a phantom with a T2 of 45ms is shown in Fig. 3. For an ROI in frontal white matter the plots show a deviation of the measured signal intensities from a mono-exponential model for short echo times. This can be explained by the presence of a short T2 compartment like myelin water.

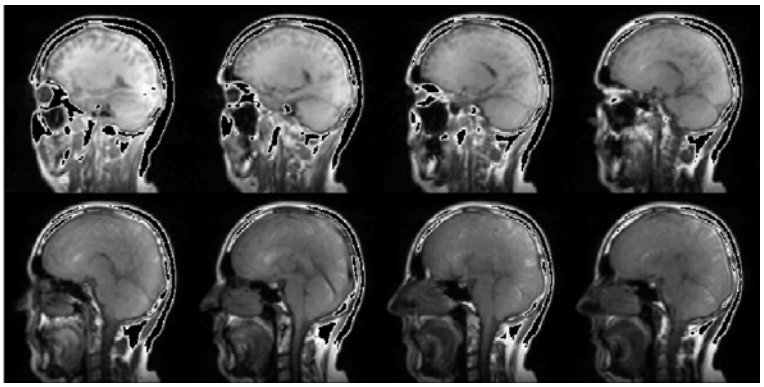

Fig. 2: Results of the multi-echo spin echo imaging sequence, TE = 1.8, 7.7, 14, 20, 26, 32, 38, 44ms from top left to down right.

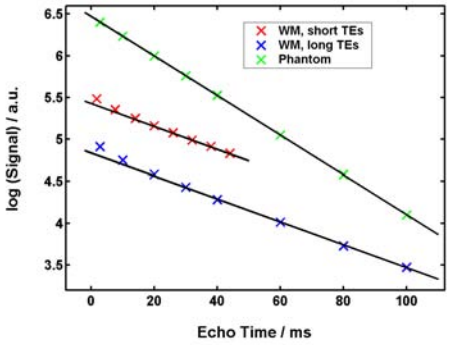

Fig 3.: Signal decay measured in white matter and a water phantom with T2=45ms.

Discussion: Our results show the feasibility of multi-echo spin echo imaging with short repetition times and very short echo times. Preliminary results show a bi-exponential signal decay in white matter at short echo times. The use of nonselective pulses for excitation and refocusing requires acquisition of the whole head to avoid folding artefacts. This limits spatial resolution and slab orientation for a given acquisition time. Parallel acquisition in 2 directions may reduce measurement time in future studies.

References:

1. Gatehouse PD, Bydder GM. Magnetic resonance imaging of short T2 components in tissue. Clinical Radiology 58: 1-19, 2003
2. Vidarsson L, Conolly SM, Lim KO, Gold GE, Pauly JM. Echo Time Optimization for Linear Combination Myelin Imaging. MRM 53: 398-407, 2005.