Diffusion Weighted MR Imaging of the Abdomen with Pulse Triggered Single Shot Sequences

P. Mürtz¹, D. Pauleit¹, S. Flacke¹, F. Träber¹, J. S. van den Brink², J. Gieseke², H. H. Schild¹
¹Department of Radiology, University of Bonn, Sigmund-Freud-Str. 25, Bonn, Germany; ²Philips Medical Systems, Best, The Netherlands.

Introduction
Diffusion weighted imaging of the abdomen is very sensitive to motion caused by breathing and by vessel pulsation. Up to now, single shot SE-EPI-sequences were acquired during breath-hold [1-5]. However, these pulse sequences used fixed values of the repetition time TR. Consequently, a series of diffusion weighted images with varying b-values is acquired in different phases of the cardiac cycle. In the present study we investigated whether the influence of pulsatile motion can be reduced by pulse triggering the single shot sequences and whether the accuracy and reproducibility of ADC-values can be improved in this way.

Methods
With a finger pulse triggered diffusion weighted single shot SE-EPI-sequence [6] twelve healthy volunteers were examined at 1.5 T (Gyroscan Intera, Philips Medical Systems, gradient system: 30 mT/m amplitude, 0.2 ms slope, 4-element surface coil). Sequence specifications are NSA = 1, TR = 4 heart beat intervals, TE = 83 ms, 4 transversal slices with 8 mm thickness, FOV = 400mm x 280mm, matrix 128x90, EPI factor 61, fat suppression). Series of diffusion weighted images were acquired at different phases of the cardiac cycle by varying the trigger delay. The diffusion weighted gradients were applied in three orthogonal directions with b-values of 50, 300, 700, 1000, 1300 s/mm² (all images for each gradient direction obtained during one breath-hold in expiration). For comparison the sequence was also acquired without pulse triggering using a fixed value of TR = 3000 ms. All measurements were repeated three times and analysed by measuring the signal intensities and determining the ADC-values within spleen, renal cortex and liver from the calculated ADC parameter maps. A water bottle was placed lateral to the body to provide a reference signal.

Results
Motion artifacts in the diffusion weighted images showed a strong dependence on trigger delay. Best results were found for trigger delays Td between 500 and 600 ms. For these values the abdominal organs appeared homogeneous on all diffusion weighted images and the highest signal intensities were detected then (figure 1).

Discussion
We have demonstrated that the motional influences on diffusion weighted images of the abdomen can be significantly reduced by pulse triggering the single shot sequences on diastolic heart phase. The quality of diffusion weighted images as well as the accuracy and reproducibility of the ADC-values are remarkably improved. Furthermore, the fact of smaller inter-individual deviations of ADC-values obtained by triggering leads to the question whether the large standard deviations reported in previous studies are caused e.g. by influences from pulsatile motion.

The sequence used in this work is suitable for clinical applications: The use of TR = 4 heart beat intervals allows the acquisition of 4 slices at the same trigger delay and guarantees unchanged ADC-values if some oximetry pulses are missed by the triggering unit. On the other hand it is short enough for breath-hold conditions. Due to the improved ADC-determination a better assessment of pathological changes is expected.

References