Ultra Fast T2-weighted TSE sequences with Flip Angle Sweep and SENSE at 3T

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Introduction: Due to their insensitivty to susceptibility effects Turbo Spin-echo (TSE)-based sequences appear to be very attractive for high field applications, where susceptibility effects can impair the image quality. And in addition the potentially higher SNR offers to reduce the scan time and / or to increase the spatial resolution. However their application at 3T interfere with high RF power deposition (exceed the specific absorption rate SAR limits for patient safety) especially with single shot TSE sequences. The SAR reduction can be obtained for example by shortening the echo train with techniques like half Fourier and parallel imaging (SENSE). Nevertheless, these methods are often not effective enough to avoid blurring and to decrease the scan time. In addition, parallel imaging especially with high reduction factor drops down the SNR. In this paper, a new method is presented, which is designed to provide high spatial resolution T2-weighted images in a very short scan time by reducing SAR considerably. 5 volunteers and 50 patients were examined with this new method at 3T.

Methods: SAR can be reduced by the application of RF-refocusing with lower flip angles. Different variable flip angle refocusing techniques are published [1,2,3] which avoids signal loss using lower refocusing flip angles. We combined flip angle sweep (FAS) with half Fourier and SENSE. This method was implemented on a clinical 3.0T system (Intera, Philips Medical Systems, Best, NL) and evaluated in 5 volunteers (contrast dependency with FAS variation of 30°, 45°, 60°, 90°, 120°, 150°, 160, 180°, all with SENSE-factor 1, 2, 3, 4 In 50 patients we measured contrast behaviour for different anatomical structures (Nucleus dentate, Pons, Nucleus ruber, Substantia nigra, Caput nucleus caudate, Putamen, Thalamus, gray matter frontal, Cortex temporal and frontal, Ventricle, Centrum semiovale) in comparison to a routine TSE sequence. Protocol description: 24 axial slices covering the brain, FOV 256, matrix 256x256, resolution 1x1x4 mm, TR/TE = 4199ms/80ms, fat suppression (SPAIR). An 8-element SENSE head coil was used. The scan time for the routine sequence was 109 seconds and the scan for the final new designed sequence was 8.4s.

Results & Discussions: Blurring artifacts impaired the diagnostic image quality with SF < 3. The optimal FAS value was found at 60° due to SNR and CNR in comparison to the conventional sequence. The contrast behaviour of different anatomical structures were similar for both sequences (ultra fast and conventional sequence). The image quality of the conventional TSE sequence is more sensitive to patient movement.

Conclusions: We have presented and successfully implemented a new method, FAS combined with SENSE, which enables T2-weighted imaging with high spatial resolution and and very short scan time. This reduced the scan about a factor 12. This new method produce images with similar contrast and diagnostic quality although the SNR is lower compared to the conventional sequence. FAS with SENSE is a very useful technique in the clinical routine especially at non cooperative patient.

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