A new Approach for High Resolution MRI of the knee at 3T – Evaluation of a moderately T2-weighted 3D-TSE-fs (SPACE) sequence

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Purpose: Magnetic resonance imaging (MRI) of the knee, one of the most commonly performed MRI examinations, still has limitations at a field strength of 1.5T in the detection of subtle morphologic changes and lesions, as the required spatial resolution and image contrast often exceed those of currently used MRI-systems[1, 2]. The introduction of higher field strengths such as 3T has increased the signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR), improving the diagnostic capabilities of MR imaging of cartilage[3, 4] and internal structures[2]. Recently a 3D-TSE-sequence with moderate T2-weighting, *S*ampling *P*erfection with *A*pplication optimized *C*ontrasts using different flip angle *E*volutions (SPACE), has become available for 3T systems. This sequence features a restore pulse and a variable flip angle distribution allowing extremely large turbo factors. The higher field strength of 3T systems allows the integration of parallel imaging with excellent SNR and CNR at a reasonable acquisition time. The purpose of this study was to evaluate a moderately T2-weighted SPACE for high resolved MRI of the knee at 3T.

Materials and Methods: Ten volunteers (age 27±3y) underwent MRI of the knee in a 3T-system (Magnetom Trio, Siemens Medical Solutions, Germany). An isotropic (resolution $0.5^3 mm^3$) sagittally oriented moderately T2-weighted 3D-TSE-fs-sequence (SPACE) (TR 1200msec/TE 30msec) was acquired and reformatted into axial, sagittal and coronal sections of 0.5mm, 1mm and 2mm slice thickness ($SPACE_{0.5mm}$, $SPACE_{1mm}$, $SPACE_{2mm}$). As reference standard coronal, sagittal and axial 2D-TSE-fs-sequences (TR 2660msec/TE 31msec/ resolution $3x0.4^2 mm^3$) were used. Signal-to-noise (SNR) and contrast-to-noise ratios (CNR) of selected anatomical structures were calculated using the subtraction method. Visual depiction of these and additional anatomical structures comprising meniscal roots and meniscofemoral ligaments was graded by two readers (consensus, 5-point-Likert-scale). Statistical analysis was performed with paired t-tests.

Results: As expected SNR of $SPACE_{1mm}$ and $SPACE_{2mm}$ was significantly higher than in $SPACE_{0.5mm}$. SNR for cartilage, bone marrow, muscle and fat was equal for 2D-TSE-fs and $SPACE_{1mm}$, for ligaments, subchondral bone and menisci significantly higher in SPACE than in conventional 2D-TSE-fs. Overall identification of anatomical structures was comparable for SPACE and 2D-TSE-fs. $SPACE_{1mm}$ showed significantly better visualization of menisci in axial sections (Figure 1) and meniscal roots (Figure 2) in coronal sections despite inferior CNR (SPACE/2D-TSE-fs: joint fluid/cartilage 103.5/144.0, joint fluid/menisci 206.3/284.8, fat/ligaments 4.2/40.7 and bone marrow/subchondral bone 7.0/4.2) (Figure3) compared to 2D-TSE-fs.

Conclusions: $SPACE_{1mm}$ yields comparable SNR to 2D-TSE-fs and appears superior in depicting relevant small ligamentous and meniscal structures - we would recommend utilization of SPACE with this slice thickness. SPACE with multiplanar reformations yields superior differentiation of anatomical structures compared to 2D-TSE-fs. Our preliminary results suggest that free isotropic reconstructions of 3D-TSE-fs datasets have the potential to become a valuable and precise tool in diagnostic work-up of the knee.

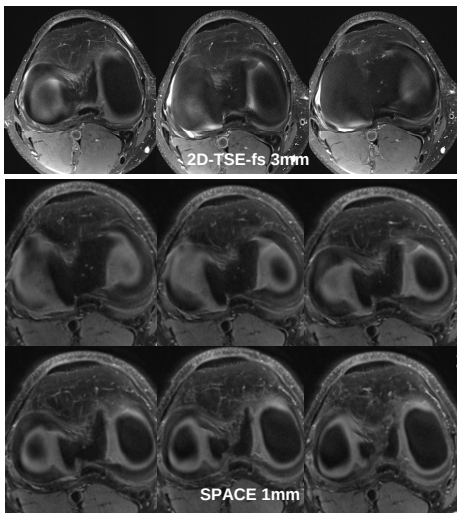

Figure 1: $SPACE_{1mm}$ allows full depiction of both menisci, depiction in 2D-TSE-fs is hampered by partial volume effects

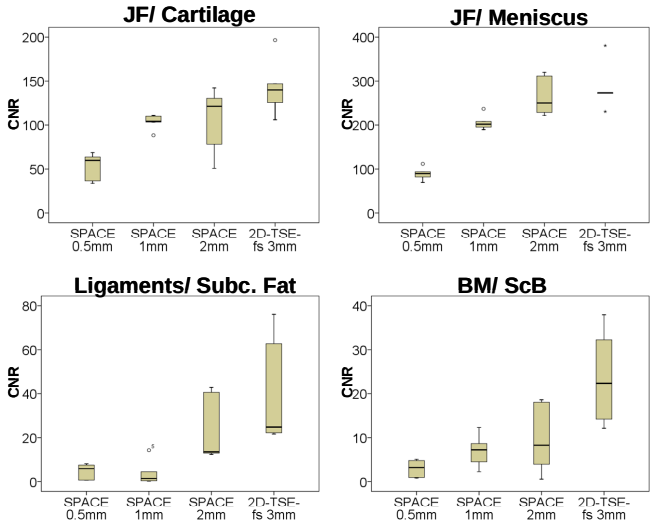

Figure 3: CNR of selected anatomical structures (JF= Joint Fluid, Subc. = Subcutaenous, BM = Bone Marrow, ScB = Subchondral Bone)

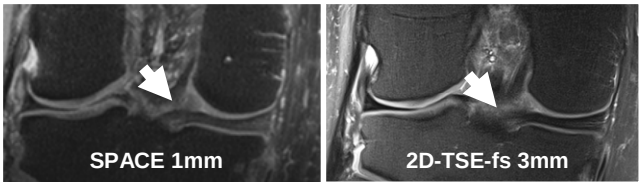

Figure 2: $SPACE_{1mm}$ allows full depiction of the posterior medial meniscal root, depiction in 2D-TSE-fs is hampered by partial volume effects

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