EVALUATION OF MULTIBAND SLICE-ACCELERATED TSE IN KNEE JOINT MR IMAGING

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Target audience: Musculoskeletal radiologists.

Purpose: To compare the simultaneous acquisition of multiple slices (SMS) (1-4) with two-dimensional turbo spin echo (TSE) sequences to routine TSE sequences in musculoskeletal (MSK) imaging.

Methods: Ten healthy volunteers and 8 patients with osteoarthritis of knee joint (3), or bone disease around the knee (1 was osteochondroma of the distal femurs; 1 fibrous dysplasia of bone of proximal tibia, 1 bone infarction of femur and tibia), or soft tissue hemangiomas (2) around the knee joint were examined using a prototype SMS TSE and routine TSE sequences at 3T (Magnetom Verio, Siemens AG, Erlangen, Germany) with an 8-channel knee coil. The basic acquisition parameters for routine TSE and SMS TSE were similar. T1-weighted sagittal imaging was performed with FOV = 160×160 mm^2, matrix = 320×256, TE/TR = 13/499 ms, slice thickness = 3 mm, slices = 36, gap = 10%, flip angle = 150 degree, turbo factor = 3; proton-density (PD)-weighted fat saturation sagittal imaging was performed with FOV = 160×160 mm^2, matrix = 320×256, TE/TR = 40/3200 ms, slice thickness = 3 mm, slices = 36, gap = 10%, flip angle = 150 degree, turbo factor = 2; PD-weighted fat saturation coronal imaging was performed with FOV = 160×160 mm^2, matrix = 320×256, TE/TR = 40/3200 ms, slice thickness = 3mm, slices = 36, gap = 10%, flip angle = 150 degree, turbo factor = 2; PD-weighted fat saturation axial imaging was performed with FOV = 160×160 mm^2, matrix = 320×256, TE/TR = 41/3200 ms, slice thickness = 3 mm, slices = 36, gap = 10%, flip angle = 150 degree, turbo factor = 2. Additionally, slice accelerated factor was 2 and FOV shift factor was 2 for SMS sequences. The signal intensity of bone, muscle, cartilage, ligament and air nearby were measured on a workstation with an 81 pixels circular region of interest. Then the signal-to-noise ratios (SNR) and contrast-to-noise ratio (CNR) were calculated by equation of SNR=the mean signal intensity (SI) of the regions/SD of air near the regions, and CNR=(|the mean SI of the $tissue_{one}$ − the mean SI of the $tissue_{two}$ adjacent to the $tissue_{one}$|)/SD of air near the $tissue_{one}$ respectively in volunteers. The SNR was compared with bone and muscle between SMS TSE and routine TSE sequence for T1 weighted images. The CNR of ligament / effusion, meniscus / effusion and cartilage / bone was compared between the SMS TSE and routine TSE sequence in the PD-weighted images. Two radiologists with more than 10-year MSK radiology experience visually evaluated all the images of 8 patients double blindly.

Results and Discussion: For T1-weighted TSE sequence, the scan time was 5.04 minutes in routine vs. 2:32 minutes in SMS TSE sequences; for PD-weighted fat saturation TSE sequence, the scan time was 5.20 minutes in routine vs. 2.40 minutes in SMS TSE sequences. The SNR of the images in volunteers were significant higher in SMS TSE than routine TSE for all T1 and PD weighted images ($p < 0.01$), except for ligament which showed no difference in PD weighted images ($p > 0.01$) (Figure 1). This demonstrated superior image quality in SMS TSE sequence relative to routine TSE sequence. The CNR with ligament / effusion, meniscus / effusion and cartilage / bone were significantly higher in SMS TSE than routine TSE for all T1-weighted images ($p < 0.01$), but no significant difference in PD-weighted images ($p > 0.05$). Motion artifacts were less in SMS TSE sequences than routine TSE sequences, which may be due to scanning time decreased in the former. For T1-weighted images, the SMS TSE sequence was superior to routine TSE regarding anatomy visualization of the cartilage, meniscus, ligament and bone trabecula, which may relate to the higher CNR and less motion artifacts, but there was no visual difference in PD-weighted imaging with fat suppression (Figure 2). Additionally, aliasing artifacts were found in the first and last slice, and the images near the edge of the coil appeared blurry in all the SMS TSE sequence.

Conclusion: SMS TSE requires less scan time and offers higher SNR compared to routine TSE sequence. Also this novel sequence can much more clearly show the ligament, meniscus and cartilage and will be valuable to be used in routine MSK examination, especially for large coverage.

References: [1]. Gaudiano C, et al. Eur Radiol. 23(6):1678-85 2013. [2]. Lu L, et al. Am J Nephrol. 34(5):476-82 2011. [3]. Wang R, et al. Proc Intl Soc Mag Reson Med. 40:476-82 2011. [4]. Wang D et al. Proc Intl Soc Mag Reson Med.1216 2014.

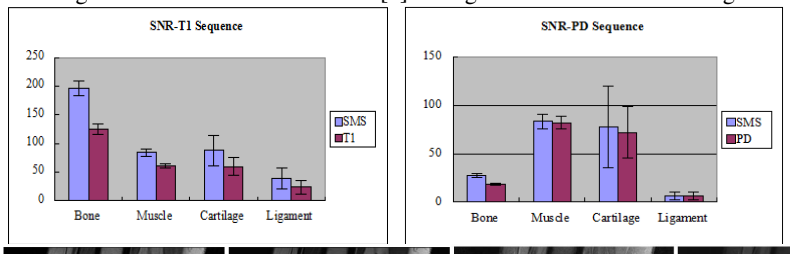

Figure 1.
The SNR of bone, muscle, and cartilage showed a significant higher in SMS TSE than conventional TSE for T1 weighted and PD weighted images, except for ligament which showed no difference in PD weighted images.

Figure 2. A 40-year-old female with osteochondroma of the distal femoral. Local thickened cartilage cap can be observed. Images were acquired with an 8-channel knee coil. Left panel (A, C and E) show multiband slice-accelerated TSE sequences, and right panel (B, D and F) show conventional TSE sequence.