3D TSE IMAGING USING SPARSE-SENSE ACCELERATION: COMPARISON WITH CONVENTIONAL 2D TSE IMAGING FOR DETECTION OF INTERNAL DERANGEMENT OF THE KNEE

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TARGET AUDIENCE
Radiologists who perform musculoskeletal imaging, researchers interested in "fast" imaging.

PURPOSE
To compare the accuracy of an optimized 3D TSE (SPACE) sequence using SPARSE-SENSE (SS) acceleration with 2D TSE sequences for the detection of internal derangement of the knee.

METHODS
An accelerated SPACE sequence prototype was developed using a variable-density poisson-disc undersampling pattern [1] of the two phase-encoding dimensions. The following were optimized: acceleration factor, turbo factor (TF), TR, TE, voxel size, fat suppression, and the presence or absence of a magnetization transfer (MT) pulse. The optimized parameters were: TR1100, TE22, TF28, variable flip angle evolution with PD weighting, SS undersampling factor of 9, fat suppression, presence of an optimized MT module, and 0.5x0.5x0.6 mm voxel size. Following optimization, this sequence (total scan time (TA 4:57)) was added to our conventional knee examination (sagittal PDW and FS T2W, coronal PDW and FS PDW, and axial FS T2W 2D TSE sequences (TA 10:56) for all patients undergoing knee MR examinations imaged on a 3T scanner (Magnetom Skyra, Siemens Healthcare) with a TxRx 15 channel knee coil. An iterative SS reconstruction [2] was performed by enforcing sparsity in the wavelet representation of the knee images. Images were then reformatted in all 3 orthogonal planes at 1.5 mm thickness. Of the 579 patients scanned using this protocol, 21 patients have undergone arthroscopy of the knee and these 21 patients comprise our study group. Two experienced MSK radiologists blindly reviewed the SS SPACE sequence and the conventional 2D TSE sequences of these 21 patients at separate sittings to evaluate for the presence or absence of meniscal or ligament tears.

RESULTS
12 patients had medial meniscal tears, 6 had lateral meniscal tears, and 8 had ACL tears. There was only 1 MCL tear and there were no PCL or LCL tears. The sensitivity, specificity, and accuracy for medial meniscal, lateral meniscal, and ACL tears on the 2D TSE images and SS Space images for each reader are presented below.

	Sensitivity		Specificity		Accuracy	
	2D	SS	2D	SS	2DE	SS
Medial Meniscus	100	100	89	100	95	100
Lateral Meniscus	71	71	79	79	76	76
ACL	100	100	100	100	100	100

Reader 1

	Sensitivity		Specificity		Accuracy	
	2D	SS	2D	SS	2D	SS
Medial Meniscus	100	92	100	100	100	96
Lateral Meniscus	71	71	93	71(p=.4)	86	71(p=.3)
ACL	100	100	100	100	100	100

Reader 2

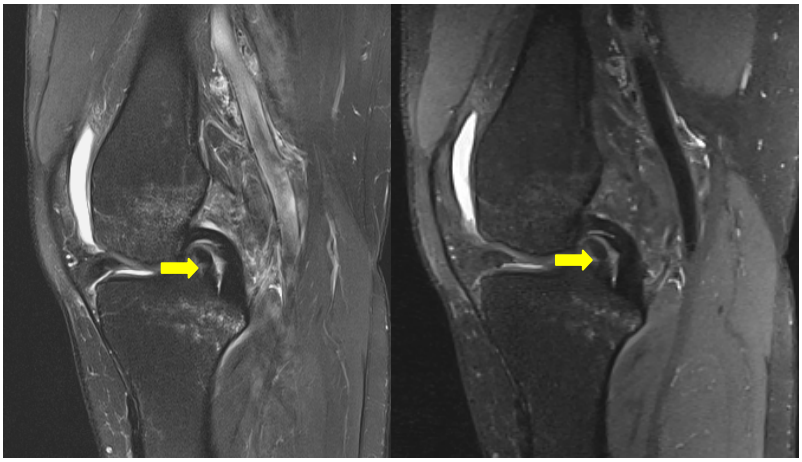

Figure 1. A) 2D TSE and B) SS SPACE sagittal images demonstrating a "double PCL" sign indicative of a displaced bucket handle meniscal tear with associated bone marrow edema.

DISCUSSION
Clinical utility of 3D TSE images has been limited by several factors including long acquisition time, blurring, suboptimal resolution, and decreased contrast compared to 2D TSE images. The use of SS combined with an optimized MT module led to increased resolution, improved contrast, and shorter acquisition times (less than 5 minutes). This optimized SPACE sequence demonstrated no statistically significant difference in sensitivity, specificity, or accuracy for the detection of meniscal or ligament tears when compared with conventional multiplanar 2D TSE sequences.

CONCLUSION
An optimized and accelerated 3D TSE sequence has the potential to replace 2D TSE sequences for evaluation of internal derangement of the knee. If substantiated in larger clinical studies, this could lead to significant shortening of exam time, potentially enlarging the indication and utilization of knee MR as well as decreasing its cost.

[1] Li et al., Proc Intl Soc Mag Reson Med, #3711, (2012); [2] Otazo et al., Magn Reson Med 2010; 64(3): 767-776