379 EVALUATION OF NEW MR IMAGING TECHNIQUES FOR ASSESSMENT OF CARTILAGE VOLUME IN THE KNEE

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Purpose: Accurate imaging of cartilage morphology is necessary to diagnose and track osteoarthritis (OA), test drug efficacy, and study surgical recovery. The gold standard in MR imaging of cartilage morphology is 3D spoiled gradient echo (SPGR). In this study, we compare two alternative imaging sequences: (1) 3D-FSE acquisition using an extended echo train acquisition and 2D-accelerated auto-calibrated parallel imaging (3D-FSE-Cube) and (2) vastly undersampled isotropic projection reconstruction (VIPR) – to SPGR with water/fat separation (IDEAL-SPGR) and parallel imaging. 3D-FSE-Cube improves upon 2D-FSE by using modulated refocusing flip angles over an extended echo train acquisition to constrain the T2 decay that leads to blurring. VIPR acquires true 3D radial sampling that begins and ends at the k-space origin in a very short TR, reducing the likelihood of banding artifact that is common to other steady-state free precession (SSFP) techniques.

Methods: Ten knees of healthy volunteers were imaged using a GE Signa HDx 3.0T MRI scanner and an 8-channel knee coil. IDEAL-SPGR was done with TR/TE 16/8 ms, BW ±31.25 kHz, 14-degree FA, 384×224 matrix, 15 cm FOV, 1 mm sections, 90 slices, acceleration factor 2, and 5:07 scan time. 3D-FSE-Cube used TR/TE 2220/24 ms, BW ±31.25 kHz, ETL 44, 256×256 matrix, 0.5 NEX, 15 cm FOV, 0.7 mm sections, 200 slices, fat-saturation, acceleration factor 3.48, and 5:00 scan time. VIPR was acquired with TR/TE 3.6/0.3 ms, BW ±125 kHz, 15-degree FA, 384×384×384 matrix, 1 NEX, 15 cm FOV, 5:00 scan time, and 3-slice averages in sagittal, axial, and coronal planes to obtain 0.39×0.39 mm in-plane resolution and 1.2 mm sections. Signal-to-noise ratio (SNR) was measured in cartilage and joint fluid, and fluid/cartilage cartilage-to-noise ratio (CNR) was calculated. SNR and CNR values were normalized to account for differences in voxel size. Cartilage volume was measured by segmentation with OsiriX. Each variable was analyzed by the Friedman test and a post-hoc paired t-test.

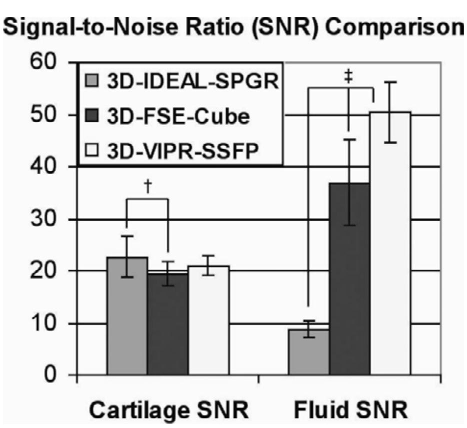

Figure 1. All three sequences have comparable cartilage SNR, with the exception that IDEAL-SPGR has higher cartilage SNR than 3D-FSE-Cube ($^{\dagger}p<0.01$). VIPR has the highest fluid SNR, followed by 3D-FSE-Cube, then IDEAL-SPGR ($^{\ddagger}p<0.001$).

Results: VIPR had comparable cartilage SNR (20.9±1.9) to IDEAL-SPGR (22.7±4.0, p > 0.1) and 3D-FSE-Cube (19.4±2.3, p > 0.1). IDEAL-SPGR yielded higher cartilage SNR than 3D-FSE-Cube (p < 0.01), likely due to its shorter TE. VIPR produced the greatest fluid SNR (50.3±5.8), followed by 3D-FSE-Cube (36.9±8.2) and IDEAL-SPGR (8.8±1.6), with related p < 0.001.

VIPR yielded CNR (29.4±6.1, p < 0.001) that was higher than the comparable CNR values of 3D-FSE-Cube (17.5±7.8) and IDEAL-SPGR (13.9±3.6, p > 0.2). VIPR, 3D-FSE-Cube, and IDEAL-SPGR all produced equivalent volume measurements of the femoral, tibial, and patellar cartilage (Friedman test, p > 0.4).

Conclusions: VIPR and 3D-FSE-Cube each has the potential to replace a 3D-SPGR/2D-FSE clinical and research imaging protocol of OA, as they are able to save time with their single isotropic acquisition. VIPR and 3D-FSE-Cube replicate the advantage of 3D-SPGR by providing accurate volume measurements. VIPR and 3D-FSE-Cube also have SNR and CNR comparable to IDEAL-SPGR, while also displaying the bright synovial fluid characteristic of 2D-FSE that may highlight cartilage surface defects and may allow for diagnosis of ligament and meniscal pathology. In conclusion, VIPR and 3D-FSE-Cube have great promise for a more rapid evaluation of OA in the knee.

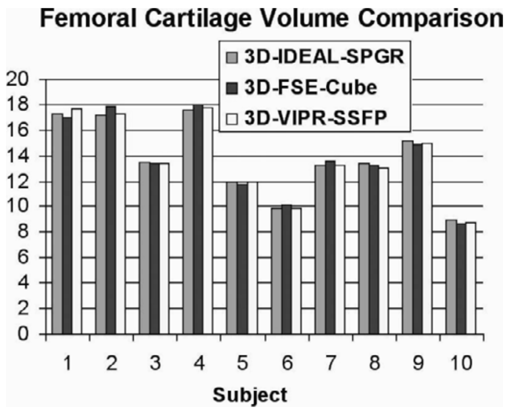

Figure 2. 3D-FSE-Cube and VIPR produced equivalent cartilage volume measurements to IDEAL-SPGR (Friedman test, p > 0.4) for femoral, patellar, and tibial cartilage.

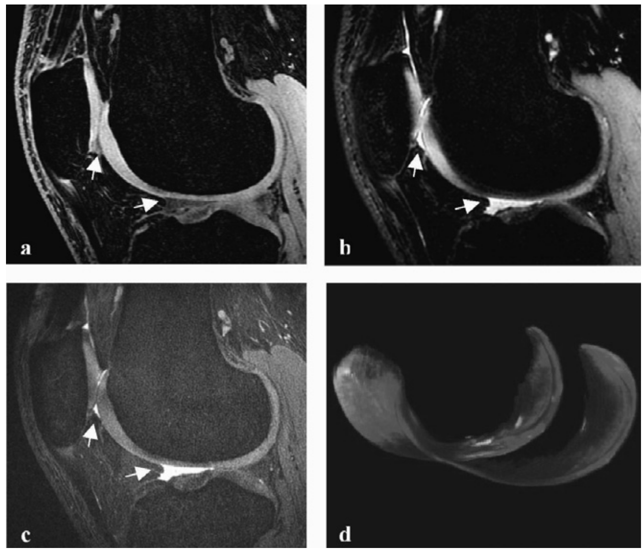

Figure 3. Images from a healthy volunteer. (a) IDEAL-SPGR water, (b) 3D-FSE-Cube, and (c) VIPR images at 3.0 T all show excellent cartilage depiction but different fluid cartilage contrast, with higher fluid signal (arrows) in 3D-FSE-Cube and VIPR than IDEAL-SPGR. (d) Model created from femoral cartilage segmentation of 3D-FSE-Cube images.

380 VALIDITY OF THE SONOGRAPHIC LONGITUDINAL SAGITTAL IMAGE FOR ASSESSMENT OF THE CARTILAGE THICKNESS IN THE KNEE OSTEOARTHRITIS

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Purpose: To compare the validity of the sonographic longitudinal sagittal image with the suprapatellar transverse axial image for assessment of thickness of femoral cartilage in osteoarthritis (OA) patients.

Methods: Fifty-one patients with knee OA were enrolled in this study. Cartilage thicknesses of medial and lateral femoral condyles were measured with longitudinal sagittal and suprapatellar transverse axial image using