# EVALUATION OF THE ARTICULAR CARTILAGE OF THE KNEE JOINT USING VASTLY UNDERSAMPLED ISOTROPIC RECONSTRUCTION (VIPR) IMAGING

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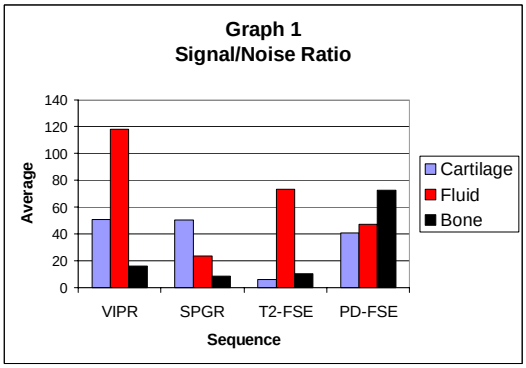
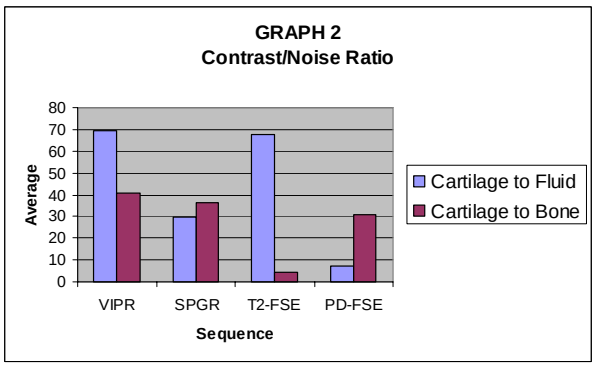
Objective: The vastly undersampled isotropic projection reconstruction (VIPR) sequence can produce high resolution 3-dimensional fat/water images using steady-state free precession (SSFP) technique (1). The banding and susceptibility artifacts characteristic of SSFP sequences are reduced due to the short TRs possible in VIPR imaging. The short TR capability of the VIPR sequence also allows the adoption of Linear combination SSFP method to generate excellent fat and water separated images without loss in signal-to-noise efficiency (2). The VIPR sequence uses near zero TE values which may benefit the imaging of articular cartilage which has short T2 components. This study was performed to determine the ability of the VIPR sequence to evaluate the articular cartilage of the knee joint.

Methods: A magnetic resonance (MR) examination of the knee was performed on 3 asymptomatic volunteers and 10 patients with cartilage defects on a GE 1.5T scanner using a phased-array extremity coil. A VIPR sequence (0.7 mm x 0.7 mm x 0.7 mm isotropic resolution and 5 minute scan time), a proton density fast spin-echo sequence (PD-FSE) (0.73 mm x 0.54mm x 4.0mm resolution and 3:30 minute scan time), a fat-suppressed T2-weighted fast spin-echo sequence (T2-FSE) (0.73 mm x 0.54mm x 4.0mm resolution and 1:42 minute scan time), and a 3-dimensional fat-suppressed spoiled gradient recall-echo (SPGR) sequence (0.63mm x 1.0mm x 1.5mm resolution and 10:08 minute scan time) were performed during all MR examinations. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) measurements were calculated for all sequences and were compared using paired t-tests.

Results: Cartilage SNR for the VIPR sequence was not significantly different than the PD-FSE and SPGR sequences. Cartilage SNR for the VIPR sequence was significantly higher than the T2-FSE sequence ($p<0.01$). (Graph 1) The VIPR sequence produced images with significantly higher CNR between cartilage and synovial fluid than the PD-FSE and SPGR sequences ($p<0.01$) and significantly higher CNR between cartilage and subchondral bone than the T2-FSE sequence ($p<0.01$). (Graph 2) On VIPR images, the intermediate signal intensity cartilage was easily distinguished from the adjacent high signal intensity synovial fluid and low signal intensity subchondral bone. The VIPR sequence provided 0.7mm isotropic resolution which allowed high quality images to be reconstructed in the axial, sagittal, and coronal planes following a single 5 minute scan. The VIPR sequence allowed excellent evaluation of the articular cartilage of the knee joint in both asymptomatic volunteers and patients with cartilage defects. (Figure 1)



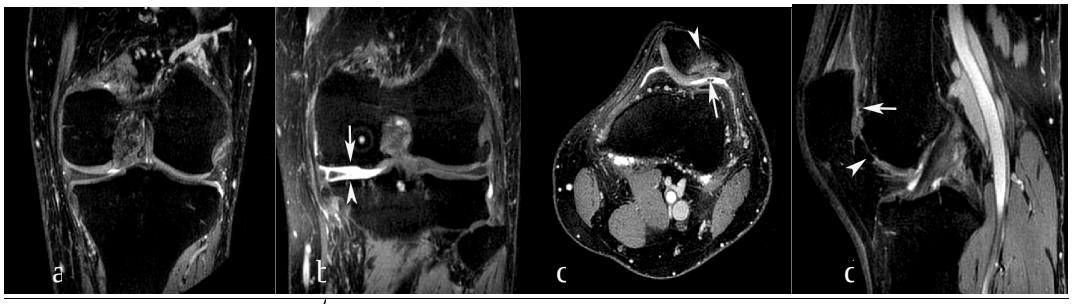




Figure 1: a) Coronal VIPR reformat image of an asymptomatic volunteer showing normal articular cartilage. b) Coronal VIPR reformat image of a patient showing full thickness articular cartilage defects of the medial femoral condyle (arrow) and medial tibial plateau (arrowhead). c) Axial VIPR reformat image of a patient showing diffuse partial thickness articular cartilage thinning of the lateral facet of the patella (arrow) with adjacent subchondral bone marrow edema (arrowhead). d) Sagittal VIPR reformat image of a patient showing diffuse partial thickness articular cartilage thinning of the patella (arrow) and a focal full thickness articular cartilage defect of the femoral trochlea (arrowhead).

Conclusion: The VIPR sequence produced multi-planar images of the knee with 0.7mm isotropic resolution in a single 5 minute scan. VIPR images had high cartilage SNR and high CNR between cartilage and adjacent synovial fluid and subchondral bone, making the sequence ideal for evaluating the articular cartilage of the knee joint.

References:

(1) Lu A, et al. J Magn Reson 2004; 18:117-123.

(2) Vasanawala S, et al. Magn Reson Med 2000; 43:82-86.