Comparison of Edema Conspicuity in Routine Knee MR Examinations using IDEAL, STIR, and T2 Fat Suppressed images at 3.0 T

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Introduction: Musculoskeletal imaging at 3.0T introduces important clinical considerations regarding assessment for edema. T1 relaxation takes longer at 3.0T than at 1.5T, increasing scanning time for STIR imaging, yet STIR imaging remains the gold standard in assessing for the presence of edema in soft tissues and bone marrow. Other fluid sensitive imaging strategies are available, but the impact of potential trade-offs has not been studied. A chemically selective fat saturation pulse is potentially more robust at higher field strengths. IDEAL images provide water-only, fat-only, in-phase, out-of-phase, and b_0 map series with a single three echo acquisition. Realizing the benefits of these approaches must be weighed against the potential to change the conspicuity of edema.

Methods: We prospectively obtained images from 10 consecutive adult patients (7 M, 3 F, mean age 53+/- 31 y) referred to BIDMC for knee MRI. The study was approved by the BIDMC Institutional Review Board and written consent was obtained from all volunteers. All scans were done on GE Signa 3.0T TwinSpeed MR imaging systems (GE Healthcare, Milwaukee, WI, USA) using an 4-element array knee coil for signal reception.

STIR, T2 weighted imaging with chemically selective fat saturation (T2WI-FS), and IDEAL images were obtained through the knee in the sagittal plane as an adjunct to a routine knee protocol. Fast spin echo STIR images were obtained with TR=4000ms, TE=27 ms, TI=180, ETL=16, BW=+/-50.0 kHz, 288x256, 3mm slice, 1mm slice gap, 16-18 cm. FOV, 2 NEX, imaging time 6-7 minutes. Fast spin echo T2WI-FS were obtained with TR=4000ms, TE=70 ms, ETL=8, BW=+/-62.5 kHz, 512x256, 3mm slice, 1mm slice gap, 16-18 cm. FOV, 2 NEX, imaging time 3-4 minutes. IDEAL images were obtained with matrix=512x256, 3mm slice, 1mm slice gap, 16-18 cm. FOV, imaging time 8 minutes. TR,TE1,2,3, and BW were adjusted to match the in-phase imaging properties with either the routine proton density (PDWI) or T2 weighted (T2WI) sequences. IDEAL parameters were alternated between PDWI and T2WI every other patient.

Evaluation of the images was performed by a board certified radiologist specializing in musculoskeletal radiology. STIR, T2WI-FS, and water-only IDEAL series were compared and relevant image features ranked 3=best series, 2= second best series, and 1=worst series. If two or more series were equivalent for a particular imaging feature, they were given the same ranking. Features evaluated included overall image quality, motion artifact, homogeneity of bone marrow fat suppression, homogeneity of soft tissue fat suppression, presence of bone marrow edema, presence of soft tissue edema, conspicuity of bone marrow edema, conspicuity of soft tissue edema, and conspicuity of joint fluid.

Results: Ten (10) knees, representing 10 patients, were evaluated. Twenty-six (26) of 30 series were considered diagnostic. Five (5) patients had bone marrow edema and 5 patients had soft tissue edema. Table 1 shows summarized results of image analysis. In all patients, all three imaging sequences agreed on the presence and/or absence of bone marrow and soft tissue edema. Overall image quality was highest with STIR and lowest with water-only IDEAL images. Edema was most conspicuous with STIR. Homogeneity of fat suppression was best with IDEAL images and worst with T2WI-FS. Joint fluid conspicuity was the same for all three sequences. Figure 1 shows A-STIR, B-T2WI-FS, and C-IDEAL series with subchondral edema in the lateral femoral condyle. The finding is most conspicuous in A, less conspicuous in B, and obscured by motion artifact in C.

Table 1: Summary of Image Analysis

	STIR	T2WI-FS	IDEAL
Overall quality	3.0	2.8	2.6
Motion Artifact	2.7	2.7	2.4
%Series considered diagnostic	0.9	0.9	0.8
Overall homogeneity of fat suppression	2.9	2.4	2.9
Conspicuity of soft tissue edema	3.0	2.7	2.7
Conspicuity of bone marrow edema	2.8	2.5	2.7
Overall Edema conspicuity	2.9	2.6	2.7

Discussion: STIR imaging is the gold standard for assessing for the presence and/or absence of soft tissue and bone marrow edema. The determination is subjective and no histological confirmation, such as biopsy, exists. Determining the presence and/or extent of edema in the extremities has implications in making a wide variety of diagnosis. When considering imaging strategies such as T2WI-FS and IDEAL it is important to consider potential changes in conspicuity and distribution of the finding of edema. Additionally, one should weigh the relative robustness of each method. This small series suggests STIR, T2WI-FS, and water-only IDEAL imaging are equivalent in determining both the presence and absence of edema, although subtle differences in conspicuity are evident. One hypothesis to explain the lower conspicuity of bone marrow edema with T2WI-FS is that a relatively longer TE combined with T2* effects in adjacent trabeculae could result in blooming that obscures subtle edema. Decreased conspicuity of edema with IDEAL was largely attributable to motion artifact. Patient motion is understandably worse with IDEAL as the triple echo sequence took 8 minutes.

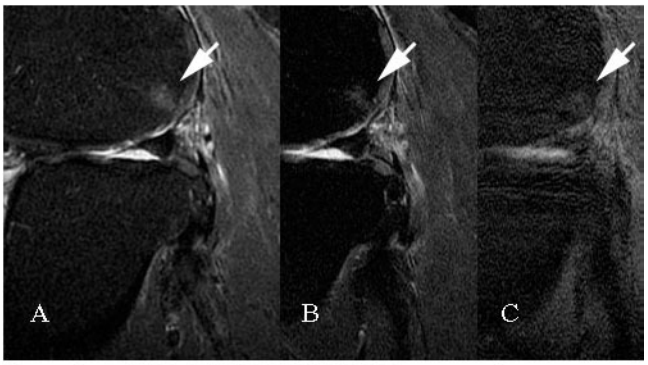

Figure 1: A-STIR, B-T2WI-FS C-IDEAL water-only
Arrow indicates subchondral edema in the lateral femoral condyle

Conclusion: T2WI-FS and IDEAL correlate well with STIR when assessing for the presence or absence of edema in bone marrow and soft tissue. Removing STIR from routine protocols may save imaging time without changing sensitivity or specificity for the determination of the presence or absence of edema.