

Magnetic resonance imaging of knee cartilage using a water selective balanced steady-state free precession sequence

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Purpose: To compare an optimized water selective balanced steady-state free precession sequence (WS-bSSFP) with conventional magnetic resonance (MR) sequences in imaging knee cartilage.

Methods: Flip angles of sagittal and axial WS-bSSFP sequences were optimized in three volunteers. Subsequently, the knees of ten consecutive patients with generalized osteoarthritis were imaged using sagittal and axial WS-bSSFP and conventional MR cartilage imaging sequences including fat suppressed 3D T1-weighted gradient echo (T1-GE), fat suppressed proton-density fast spin echo (PD-FSE), and fat suppressed T2-weighted fast spin echo (T2-FSE). We measured acquisition times and calculated contrast to noise ratios (CNR) between cartilage and the cartilage surrounding tissues to quantitatively analyze the various sequences. In two other patients we compared the accuracy of cartilage volumes measurements performed on WS-bSSFP and conventional T1-GE images with those measured on anatomical sections of the tibia plateau harvested after total knee arthroplasty for severe osteoarthritis.

Results: Optimal CNR using WS-bSSFP sequences was obtained with a 20-25 degree flip angle for axial and sagittal orientated images. Total imaging time required was less with WS-bSSFP (5min 5sec) than T1-GE (7min 55sec) sequence and one minute longer than dual PD-FSE and T2-FSE (8min 5sec) sequence. CNR of cartilage and its surrounding tissues was higher in WS-bSSFP images compared to conventional images (1.8 times higher compared to T1-GE images (figure 1), 3.5 compared to PD-FSE images and 3.8 compared to T2-FSE images). The WS-bSSFP sequence provided higher accuracy in the determination of cartilage volume than T1-GE sequence. Mean difference of anatomical specimen with WS-bSSFP was 0.06 ml, and with T1-GE 0.24 ml.

Conclusion: Water selective balanced gradient echo MR imaging sequence allows, relative to conventional MR imaging sequences, optimal imaging of cartilage in the osteoarthritic knee, with clinically acceptable acquisition times.

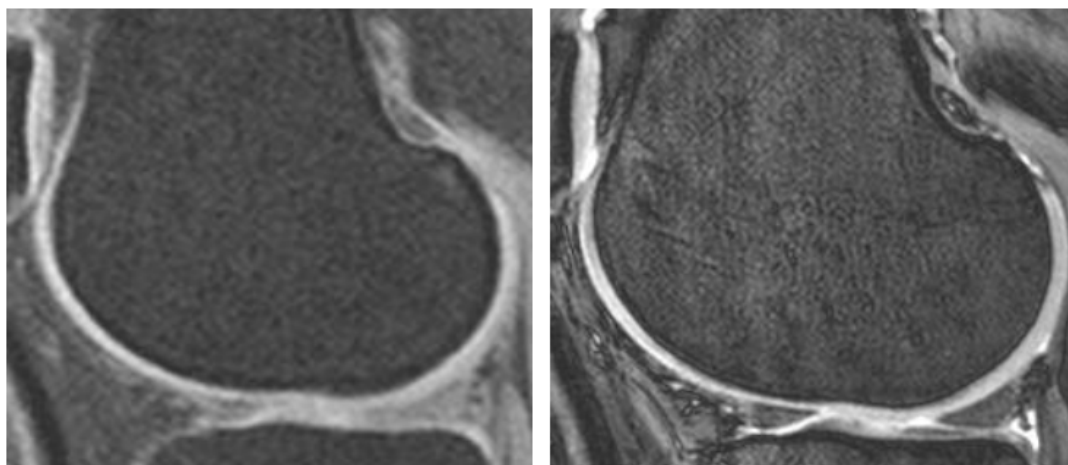


Figure 1. Comparison of fat suppressed T1-GE image (left), and the WS-bSSFP image (right). The latter shows better cartilage surface detail and less blurring of cartilage.