MRI OPTIMIZATION AND FEASIBILITY OF ORTHOPEDIC KNEE APPLICATION ON 7T VERSUS 3T

A. Craig[1], M. Kleingartner[1], K. Rich[1], D. Stanley[2], D. Thedens[1] and V. Magnotta[1]
[1]University of Iowa [2]GE Healthcare

PURPOSE

High field 3T MRI is the benchmark for musculoskeletal applications and clinical research. The utilization of a 7T scanner offers the potential for providing even greater anatomical detail of extremities and intra articular structures. In this study we look to demonstrate the feasibility of a clinical orthopedic knee protocol on a 7T scanner as well as determine if scans obtained on a 7T scanner provide the expected increase in resolution and overall image quality as compared to a 3T scanner.

METHODS

Five healthy volunteers were screened for MRI contraindications. Exclusions to the study included any foreign body that was not an orthopedic or dental implant. Images of the knee were collected on a MR950 7T scanner as well as a MR750w 3T scanner (GE Healthcare, Milwaukee, WI USA). Each volunteer had the same knee scanned twice, first at 3T and subsequently at 7T. An identical clinical knee protocol (Table 1) consisting of sagittal T1 and T2 fat sat sequences were acquired for each participant on both scanners. In addition, an optimized protocol (Table 2) was also run on the 7T. Signal-to-noise ratios (SNR) and contrast-to-noise ratios (CNR) were calculated for each sequence using the subtraction method [1]. CNR was assessed by specific anatomy, cartilage-fluid on the T1 sequences and cartilage-bone for the T2 fat sat. Following determination of SNR and CNR, averages at each distinct protocol and field strength were attained.

Table 1.

Clinical Knee Sequences

PARAMETERS	T1	T2 Fat Sat
FOV	150mm	150mm
TR/TE	674/8.8	4450/72
Matrix	384x320	352x256
Slice Thickness	3mm	3mm
NEX	2	2

Table 2.

Optimized 7T Knee Sequences

PARAMETERS	T1	T2 Fat Sat
FOV	150mm	150mm
TR/TE	1125/11	4000/64
Matrix	384x320	384x320
Slice Thickness	3mm	3mm
NEX	2	2

RESULTS

For the same protocol run across scanners the 7T images had higher SNR by a factor of 1.1 and 5.1 for the T1 and T2 fat sat images, respectively, as compared to 3T. CNR measurements in for this protocol showed similar results. When comparing the optimized 7T protocol as compared to the 3T protocol, the 7T images had improved SNR by a factor of 1.4 and 2.0 for the T1 and T2 fat sat images, respectively. The average SNR and CNR measurements across all of the participants are shown in Figure 1. Comparative images for all six scans are shown in Figure 2.

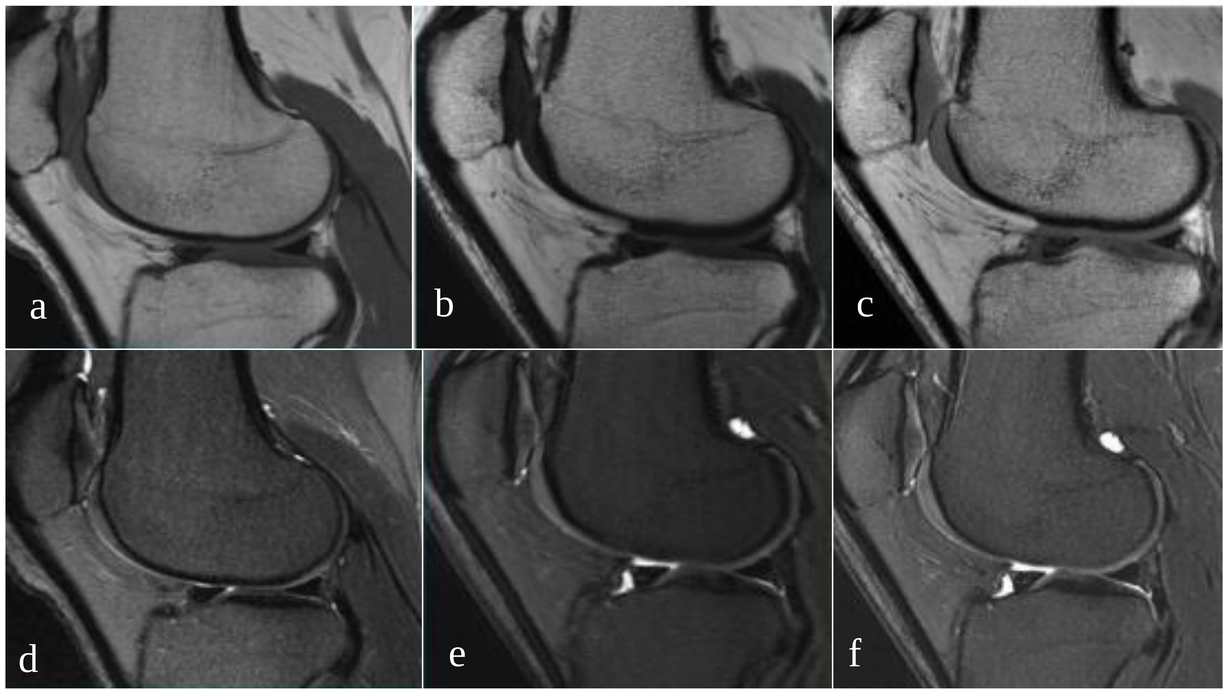

Figure 2. Top row: Sagittal T1 clinical knee images acquired on 3T and 7T (a,b). Optimized T1 image acquired on 7T (c). Bottom row: Sagittal T2 fat sat images acquired on 3T and 7T (d,e). Optimized T2 fat sat images acquired on 7T (f).

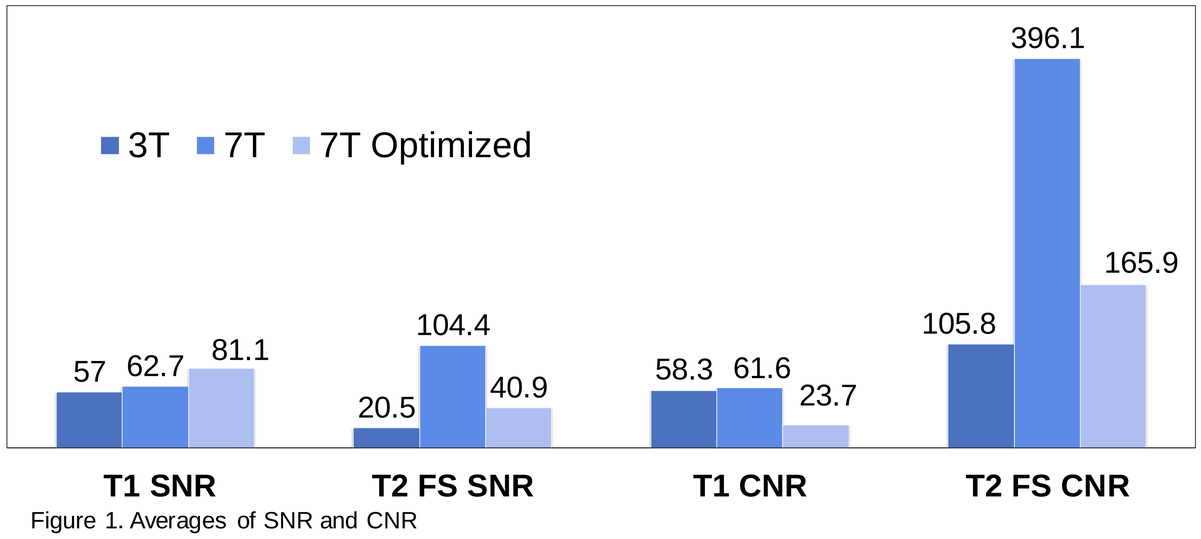

Figure 1. Averages of SNR and CNR

CONCLUSION

The results of the study revealed that there is an increase in SNR and CNR in the resulting images at 7T as compared to the 3T images. Based on the results, the “optimized” 7T protocol did not provide the highest SNR and CNR for the T2 fat sat images suggesting that there is potential for further improvement in the imaging protocol. The optimized 7T protocol did increase the in-plane resolution by a factor of 1.1 and 1.25 in the frequency and phase directions respectively while maintaining a higher SNR and CNR in the images. Both 7T knee protocols provided enhanced image quality while maintaining similar scan acquisition times. This study shows that a stable clinical knee protocol can be developed on a 7T scanner. Scanning at 7T offers vast potential for routine imaging of the knee and musculoskeletal anatomy in a clinical setting. Further work is needed to fully optimize the 7T imaging protocol to take advantage of the higher signal available on the scanner.

References: 1. Dietrich et al. Measurement of signal-to-noise ratios in MR images: Influence of multichannel coils, parallel imaging, and reconstruction filters. JOURNAL OF MAGNETIC RESONANCE IMAGING 26:375–385 (2007)