

Multi-channel transceive coil for improved knee imaging at 7T

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Introduction:

An important application that can benefit from high signal-to-noise ratio (SNR) of high fields (7T and above) is musculoskeletal imaging (MSK) [1, 2]. The ability to see structures as fine as cartilage can prove to be valuable when evaluating the knee for morphology [3] and degradation with age, as well as, evaluation of the knee post surgery. High resolution images, as well as, T2- and T1rho- maps of structures such as cartilage require very high SNR. In order to detail the contrast and signal in such miniscule structures, it is essential that homogeneous images are produced by efficient coils. An additional dilemma with knee imaging is the presence of the other knee, which can couple to the signal produced by the coil, and be present in the image. This intrusion reduces the Field of View (FOV) and eliminates the resolution gains achieved at high fields.

In this paper, we present a robust 8 channel transceiver array coil [4] driven with multichannel radio frequency amplifiers. To eliminate the impact of the other knee in the FOV, the ground planes of the strip elements are connected with neighboring ground planes via conductive strips and large capacitors to eliminate the leakage of magnetic fields outside the coil. This creates a Faraday cage structure without the creation of Eddy currents. Imaging results obtained with this coil at 7T for the knee are presented.

Methods:

An eight-channel transceiver array was constructed with Cu tape and Teflon holder (Fig. 1a). The strips had element widths and lengths of, 1.9 cm, 16.5 cm, respectively. The inner diameter of the Teflon holder ($\epsilon_r = 2.08$) was 20.3 cm and the substrate was 1.9 cm thick. In between the ground planes of the resonant elements Cu tape (5 cm wide) was placed and 330 pF capacitors were used to connect the ground planes of the resonant elements with conductor strips between the elements (Fig. 1b). Each element was individually tuned to 297 MHz (7 T) with decoupling capacitors between elements to achieve nearest neighbor decoupling [5], and matched to a 50- Ω , coaxial signal line. All experiments used a 7T magnet with a Siemens console and custom 50 ohm T/R switches. The transmit phase of each element was adjustable.

Proton density weighted Turbo spin echo (TSE) of the knee joint was acquired (TR/TE = 4960/22 ms, Resolution: 0.57 x 0.57 mm², Slice thickness: 2 mm Matrix: 256 x 256, 20 slices).

Results:

The impact of the coil shielding is illustrated in Figure 2a, b. The subject's other knee is present in the coronal Flash acquisition with no shielding; this effect is suppressed in the image when the Faraday cage is applied around the coil (no suppression pulse was applied to these images). The coil produces homogeneous excitation in the knee with high SNR (Fig 3a). The high resolution imaging permits the depiction of the popliteal artery and tibial nerve internal organization (Fig.3a). The B1 map of the axial slice in Figure 3a (30 degree nominal flip angle) illustrates the homogeneity produced by the coil.

Conclusions:

Initial results demonstrate high resolution in knee imaging can be achieved taking advantage of the gain in SNR at ultrahigh magnetic field. This coil produced homogeneous images and allowed for the visualization of detailed structures in the knee. The addition of shielding in this coil confined the field inside the coil and successfully suppressed the other knee. This design approach could be used for future RF coils dedicated to extremity imaging.

References : [1] Gold GE *et al*, *American Journal of Roentgenology* **183**:343 (2004); [2] Goerke *et al*, *ISMRM* 2008, pg. 144 [3] Regatte RR and Schweitzer ME, *JMRI* **25**: 262 (2007), [4] Adriany,G. *et al*. *Magn Reson Med* 2005; 53(2): 434-445; [5]Wang, J. *Proc. 4th ISMRM* p.1434 (1996)

Acknowledgements: This work was funded by Keck Foundation, BTRR - P41 RR008079; NIH-R01 EB000895;NIH-R01 EB006835

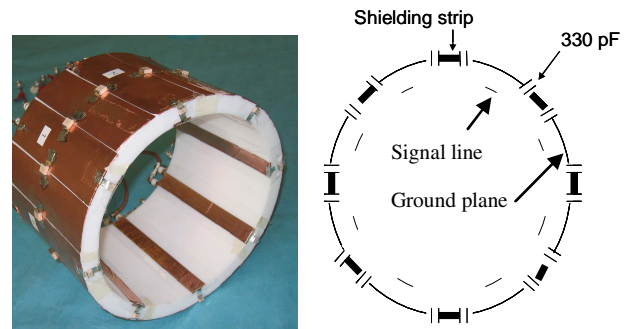


Fig 1a) 8 channel knee coil b) 8 channel knee coil schematic

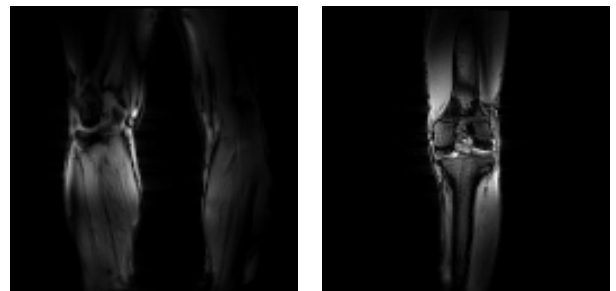


Fig 2a) Coronal FLASH image of knee without shielding b) coronal FLASH image of knee with shielding

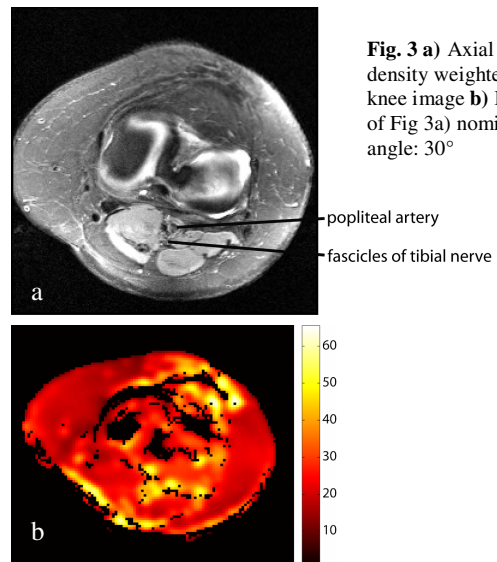


Fig. 3 a) Axial proton-density weighted TSE knee image b) B1 map of Fig 3a) nominal flip angle: 30°