A Hybrid QD Transmit/8-Channel Receive Array Knee Coil at 3T

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Introduction

3D-Fast Imaging Employing STeady-state Acquisition (3D-FIESTA) can provide very high-resolution imaging with less motion artifact using very short TRs. Shorter TRs and higher flip angles increase SNR [1]. Using 3D-FIESTA on knee imaging will give higher resolution and contrast. However, the use of a standard birdcage whole body coil at 3T as transmitter easily exceeds SAR limitations on a human patient, owing to its rigorous nature of 3D-FIESTA sequences. One way to reduce SAR is to use a smaller localized transmitter over only a desired FOV, in this case, only the knee regions. From Maxwell equations, with the assumption of uniform B1 field and no conservative potential inside the standard birdcage coil, the maximum E field may be written as $E \propto \omega B_1 r$, where ω is the angular frequency of RF field and r the radius of the coil. The SAR is then $\propto |E|^2 \propto (\omega B_1 r)^2$. Therefore, reducing the size of birdcage transmitter gives rise to significant reduction in SAR. The proposed coil here consists of one cylindrical quadrature-driven (QD) birdcage coil as transmitter and 8-overlapped loop array coils as receiver coils, positioned inside the birdcage transmitter. The configuration of receiver coils is also designed for parallel imaging [2].

Methods

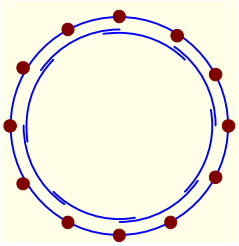
Fig.1 shows the axial-cut and block diagram of the hybrid T/R knee coil, and Fig. 2 shows a mechanical package drawing of the coil. The transmitter coil is a 12-rung birdcage coil. Both the diameter and the length of the coil are 22 cm. The birdcage coil can be switched ON in transmitter mode and OFF in receiver mode using pin diodes switching circuit. With SNR enhancement and better fit to the contour to the knee anatomy in mind, eight receiving loop array elements were built on a tapered cylinder in the SI direction. The diameters of two sides of cylinder are 18 cm and 20 cm, respectively. The length of loops is 18 cm. The adjacent loops were overlapped to cancel mutual inductance coupling. Low impedance preamplifier was also used to increase decoupling among coil elements [3]. The receiving loops are decoupled from the birdcage transmitter coil using decoupling circuits in the transmitting mode.

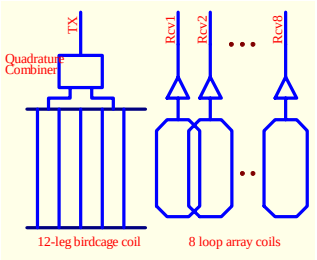
Results and Discussion

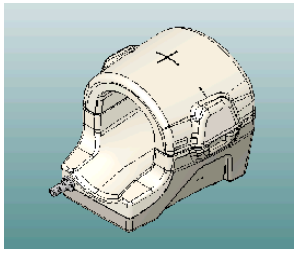
This coil was tested using a GE EXCITE 3.0T 8-Channel MRI system. The performance of this coil was compared with a commercial quadrature T/R knee coil whose dimension is similar to the proposed hybrid knee coil. Based on the evaluation results on phantom and volunteer scans, the hybrid knee coil power requirement was 2dB less than that of the commercial coil with the same protocol. The SNR was about 40% more than that of the commercial coil. Fig. 3 shows the axial images of the hybrid coil and the commercial coil. The hybrid coil also shows good results in parallel imaging at acceleration factor 2.

Conclusion

A 3T low SAR hybrid T/R 8-channel array knee coil was built and tested. System tests showed a low power requirement, higher SNR and good parallel imaging results with the proposed hybrid coil. In particular, 3D-FIESTA sequences run successfully with this hybrid coil.







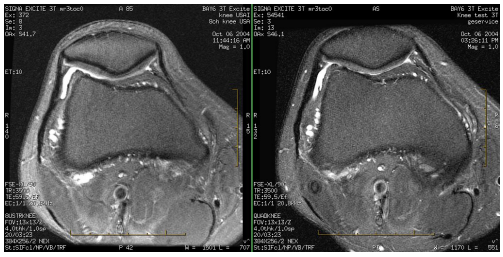


Fig. 1 Axial-cut and block diagram

Fig. 2 Mech. package drawing

Fig. 3 Axial images: hybrid (left) vs. quadrature (right)

References

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