A 21 channel Transceiver Array for Non-human Primate Applications at 7 tesla.

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Introduction

Multichannel decoupled strip line coils have been successfully used for parallel excitation and RF shimming applications at 7 tesla and above [1,2]. While the distinct sensitivity profiles of such coil elements are beneficial in terms of parallel excitation and coil decoupling performance, the close proximity of the RF ground plane to the coil conductor strip potentially reduces RF penetration and the achievable SNR [3]. By contrast, close fitting receive arrays consisting of small unshielded loop coils have consistently proven to yield highest SNR at 7 tesla [4,5]. Moreover, due to the perpendicular nature of the primary B_1 fields generated by strips and loops, such coils can be combined and decoupled, as long as the strip line is positioned along the central axis of a loop coil. A combination of transceiver strip lines with receive loop arrays increases the number of decoupled receiver channels and is also expected to optimize penetration and SNR. The aim of the study was to built and evaluate this combination of transmit and receive arrays for non human primate applications.

Method: A coil holder (19 cm i.d.) for the sixteen 12 cm long strip line transmission lines was designed with integrated ear bars to allow for consistent positioning of non human primates (Fig. 1 a-d). To accomplish this, the coil was split along the central axis. Individual transceiver elements were built from 3 cm wide, 12 cm long and 1.2 cm thick Teflon bars. A 3-sided ground plane was used to reduce intra coil coupling and to further improve the distinctness of the sensitivity profiles. Decoupling capacitors were used between next nearest neighbor coils. This transceiver array was combined with a five channel receive loop array consisting of coils of ~4 cm diameter each (Fig. 1B). Both preamplifier [5] and overlap decoupling was utilized to reduce correlated noise for the loop arrays and the coils were actively detuned during transmission. A slot at the top of the transceiver array holder allowed for accurate mechanical alignment of the receive array relative to the transceiver array. Coil coupling was evaluated in bench measurements and through acquisition of noise correlation matrices. Parallel imaging performance of the receiver array itself and when using all channels was evaluated using a tight FOV for a monkey head and 1/g factor maps in the left –right direction for a central coronal plane were calculated for reduction factors up to 4.

Results and Discussion: To accommodate variety in head size and position, it was essential to allow some flexibility in the mounting of the receive arrays. We were able to allow for such variation, while still maintaining sufficient coil decoupling of at least 10 dB. Figure 2 shows a typical noise correlation matrix. The 1/g factor maps in Figure 3 indicate typical parallel imaging performance gains achievable with the combined coils compared to the 5 channel receive coils. The average g-factor for the combination of 16+5 receiver channels improved to 1.66 for a reduction factor of 3 compared to 2.66 for the 5 channel coil. The combined coil also significantly increased coverage. SNR was improved in areas not predominately covered by the close-fitting receive loops. The 21 channel coil supports fast imaging and DTI data acquisition with reduction factors of up to 4. Figure 4 shows an example of a T2 weighted image acquired utilizing all 21 array channels.

Conclusion:

We have demonstrated that it is possible to simultaneously receive with strip line transmit arrays and dedicated loop receive arrays. Clear gains in parallel imaging performance were realized. Gains in SNR from inclusion of the transmit array elements during reception were more modest and only significant in the lower half of the brain and in head areas not covered by the receive loops. These results indicate that, while the most significant gains in both parallel imaging performance and SNR are directly related to number and size of close fitting receive loops, utilization of transmit array elements during reception can also be beneficial. Future coil development will focus on further reducing the size and increasing the number of the receive loops.

References:

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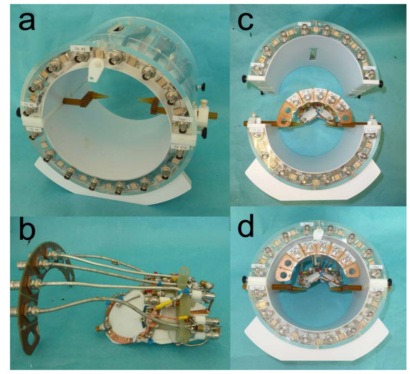

Fig. 1 a: 16 ch Transceiver Array. b: 5 ch Rx Array c,d: Combined Coils (16Tx/21 Rx)

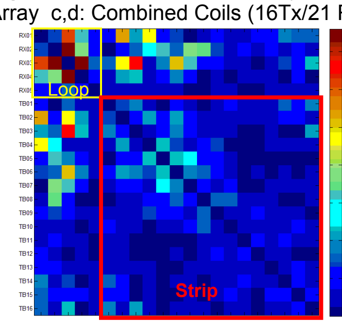

Fig.2 Noise Correlation Matrix. Loop coils (yellow) and Striplines (red)

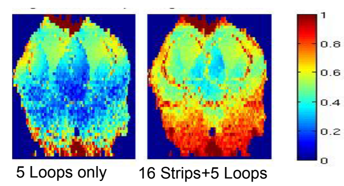

Fig.3 1/g maps comparison obtained in a central coronal slice for 3x reduction

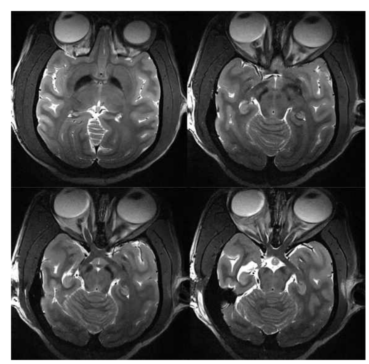

Fig.4 Imaging example of a non-human primate; T2-weighted, Resolution: 0.25 x 0.25 x 0.7 mm^3;PI = 2; nt=4; ~7:30 min acquisition