Novel RF-coil assembly to simultaneously investigate fMRI and electrophysiology in non-human primates in a large bore vertical magnet

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Introduction

The combination of electrophysiology and fMRI in non-human primates at high field poses some unique challenges for the design of RF-coils. The design needs to be sufficiently open to allow for electrode access to the brain, while at any one time different areas might be recorded or multiple electrode shanks may be used[1]. Patch antennas allow for a more open design and have been used for primates in 7T human scanners[2,3]. Since our bore size of 38 cm is too small for a 300 MHz traveling wave we developed an open quadrature transmit coil/antenna placed in-situ. This device can be used alone in transceiver mode or in combination with dedicated receive arrays[4] to allow for maximum flexibility while maintaining a high SNR.

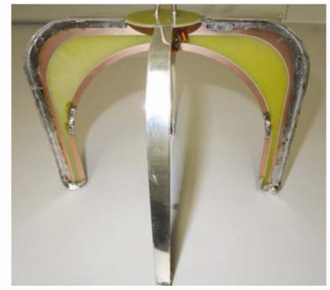

Fig. 1. Quadrature antenna coil

Methods

Figure 1 shows the transmit antenna, and figure 2 its positioning over the monkey's head (top view) allowing access to occipital lobe, frontal lobe and temporal lobes. The coil consists of two crossed and curved dipole loops terminated with lattice-baluns. The quad assembly is hooked up to the scanner via a commercial hybrid that was modified with bias tees to allow detuning when the antenna is combined with a receive array. The antenna can be used in transceive- as well as in transmit-only mode. Experiments were performed on a vertical 7T Bruker BioSpec on anesthetized monkeys (*macaca mulatta*). The setup and methods have been described previously[1,4]. Anesthesia was a balanced remifentanil/mivacurium regimen. GE-anatomical images were acquired at a resolution of 210x330x1000 μm^3 for axial images, 250x375x1000 μm^3 for sagittal images with TE/TR = 22/2000 ms. Data were analyzed using custom routines in MatLab (the MathWorks).

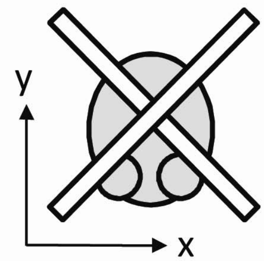

Fig. 2. Positioning of the coil

Results

Figure 3 shows a GE image of a phantom containing saline and acrylic tubes aquired in transceive mode. This 8-cm phantom has about the same size as a macaque head, indicating that the coil provides a sufficiently homogeneous B1-field. The anatomical images of the monkey (Figure 4) show that in combination with a phased array, the coil is able to provide very high quality images, indicated by the fact that the Gennari line in primary visual cortex and penetrating venules are visible throughuout the brain, while at the same time maintaining whole-head coverage within a reasonable scan time (8.5 min).

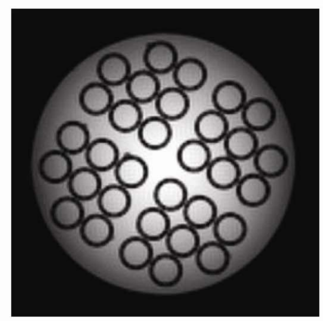

Fig. 3. GE-image acquired with the antenna in transceive mode

Conclusion

The transmit coil/antenna is capable of producing a sufficiently homogenous B1 field while maintaining the open design that allows for easy access to the brain. In combination with a receive-only phased array[2] it is able to provide very good SNR and acceleration, allowing for applications that require very high spatial or temporal resolution. This has the potential to allow fMRI at high spatial and temporal resolution in combination with electrophysiology.

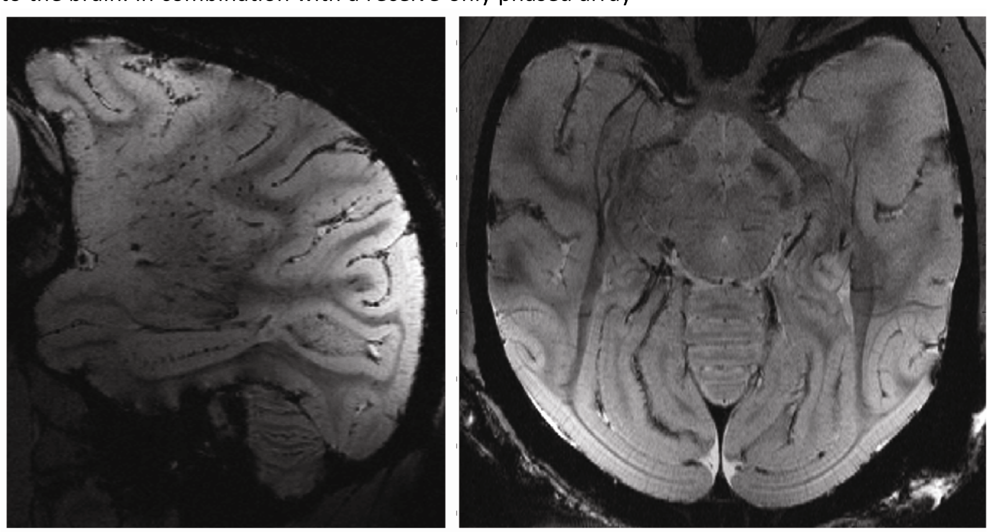

Fig 4. High-resolution GE images acquired with the antenna and an 8-channel phased array, spatial resolution 250x375x1000 μm^3 (left) and 210x333x1000 μm^3 (right)

References

1. Logothetis et al., Nature 491:547-553 (2012); 2. Nakajima et al., Magn. Res. Med. Sci. 6:231-233 (2007); 3. Mallow et al., MAGMA 26:389-400 (2013); 4. Goense et al., Magn. Reson. Imag. 28:1183-1191 (2010);