Pre-clinical imaging at 9.4T using a versatile 8-channel Transceive Array

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Introduction

In our previous work [1-3], a 9.4T 8-channel actively detunable small animal transceive volume array, capable of operating in transmit and/or receive (Tx/Rx) mode, had been presented. It has been shown that the volume array is capable to perform standard MR imaging, Parallel Excitation (PEX)/Transmit SENSE and Spatially Selective Excitation (SSE) imaging. The capability to perform these different examinations using the volume array alone is beneficial but for small animals (smaller filling factor) it is more favourable to use independent receiver-only coils to gain higher SNR. The concept of using local receive-only coil to improve the SNR is intriguing and to test whether the volume array can also be used in this setup, a 2-element receive-only quadrature phased array coil had been combined with the volume array and *in-vivo* imaging of a small rat was undertaken.

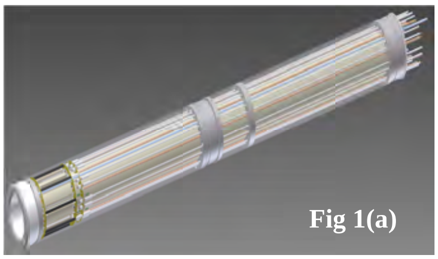
Fig 1(a)

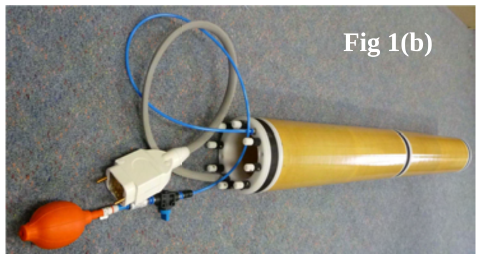
Fig 1(b)

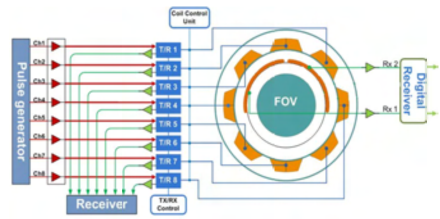

Fig 2

Methods

Depicted in Fig.1 (a) and (b) is the 8-channel transceive volume array and Fig 2 is the combined setup of the volume array with the 2-element receive-only phased array coil. All coil elements (from the volume array and local array coil) are equipped with fast active detuning circuitry consisting of PIN-diode and biasing circuitry which are controlled via an external Coil Control Unit (CCU). It is important to ensure the active detuning circuitry is performing optimally because any interferences between the volume array and the local array will distort the homogeneity of the transmit B_1 field and the received MR signal. This is performed using network analyser observing the S-parameter of each coil element using the setup shown in Fig 2. Upon confirming all active detuning circuitries are functioning the volume array and the local array loaded with a rat were tested in a 9.4T 30cm BioSpec-system (Bruker BioSpin MRI GmbH; Ettlingen, Germany) equipped with eight separate transmit and receive channels. Each channel is equipped with low noise pulse-protected preamplifiers (Rinput=50 Ω, NF=0.6 dB, gain 22 dB) and can be controlled independently; all combinations of the coil-elements for transmitting and receiving during the MR-experiment were possible. Tuning and matching of the volume array and local array are carried out within the MRI system.

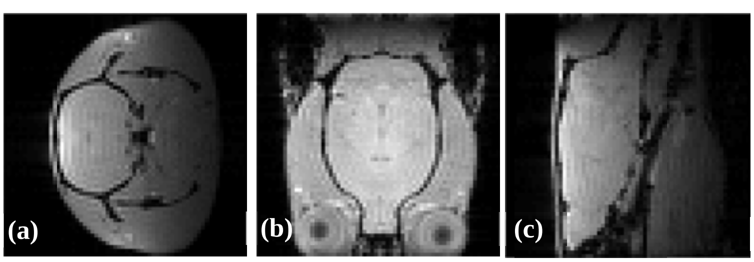

Fig 3

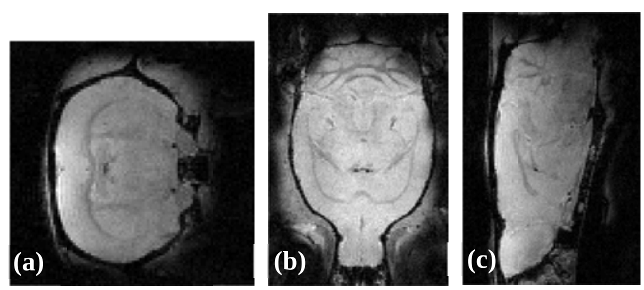

Fig 4

Results

A standard gradient echo brain imaging on the small rat is first performed. Shown in the Figs 3(a-c) are the acquired axial, coronal and saggital images. Apart from testing the array coils for standard MR imaging, they are also tested for Inner Volume Imaging by Phase Encoding (IVIP), which has shown that spatial selectivity can be enhanced by mitigating certain limitations of SSE pulses which otherwise significantly deteriorate the amplitude modulation accuracy [4]. A 3D FLASH sequence was applied in which the excitation pulse was substituted by a 3D parallel SSE pulse. Shown in the Figs 4(a-c) are the acquired axial, coronal and saggital brain images of the rat using the IVIP approach.

Discussions and Conclusion

In this work, the combination of using the 8-channel actively detunable transceive volume array with a local receive-only phased array coil has shown to be feasible. The acquired images show no evidence of residual coupling between the volume array and the local array coil. This demonstrated the robustness of the volume array. Therefore the volume array can be optimally used for imaging of large or small rats with high SNR.

References [1] Weber *et al*, ISMRM, pp. 151, 2008. [2] Li *et al*, ISMRM, pp. 3833, 2010. [3] Weber *et al*, ISMRM, pp. 3836, 2011.[4] Schneider JT. et al, ISMRM, pp. 204, 2011.