Comparison of Transmit Coil Configurations for Multiple-Mouse MRI with Receive-Only Coils

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Introduction

In human MRI, it is common to use one radiofrequency coil to produce a homogeneous excitation field, but use a separate surface coil or array of coils for increased detection sensitivity. Multiple-mouse MRI (MMMRI) accelerates preclinical studies by imaging multiple mice simultaneously [1]. Although MMMRI was originally reported using an array of shielded transmit-receive (Tx-Rx) coils, it also stands to benefit from using dedicated Rx coils. While the Rx coils in such a MMMRI setup can be tailored to a specific application, there are only two competing configurations for the transmit coils: (A) separate, shielded Tx coils for each mouse; or (B) a single large Tx coil encompassing all mice. The objective of this work is to compare these two configurations on a 7T MMMRI Varian imaging system.

Methods

To compare Tx coil configurations, we tested the simple case of two imaging samples. In the first configuration (Fig. 1A), two shielded birdcage Tx coils (OD 60mm, ID 40mm, RAPID MR International) were mounted adjacent to one another. We constructed two diode-detunable saddle coils (ID 19mm) to serve as Rx coils. In the second configuration (Fig. 1B), two Tx coils were replaced with a single large-volume shielded birdcage Tx coil (OD 154mm, ID 135mm) of sufficient size to image at least 7 mice simultaneously. In each case, we acquired two sets of images, one with a full field-of-view (FOV), 102.4x38.4x25.6mm, covering both samples, and one with a reduced FOV, 38.4x19.2x25.6mm to cover a single sample. Images from the large FOV and from configuration A were reconstructed by standard Fourier transform methods. For the small FOV images in case B, a modified sensitivity-encoding (SENSE) reconstruction was used [1, 2], wherein the coil sensitivity was taken as a constant for all pixels (corresponding to our observation that aliased ghosts were primarily due to electromagnetic coupling with an effective g factor of 1.2). Images were acquired using a 3D gradient echo with parameters: TE/TR = 5.4/250 ms, matrix 384x256x64 (large FOV) and 384x192x256 (small FOV) and scan time of 27mins (large FOV) and 1hr22mins (small FOV). Large FOV images were used to quantify ghosts and determine coil sensitivity. Small FOV images represented the desired high-resolution acquisition were used for SNR measurements.

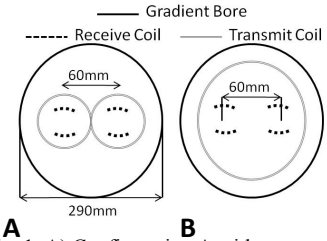

Fig. 1. A) Configuration A with two separate shielded Tx coils. B) Configuration B with one large shielded Tx coil.

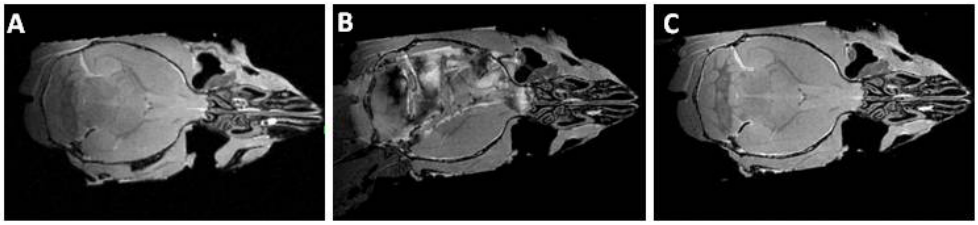

Fig. 2. A) Small FOV 100µm image for Tx configuration A: B) Fourier reconstruction of configuration B of the same slice shows ghosting C) SENSE reconstruction removes ghost artifact.

Results and Discussion

Fig. 2 displays the images from a fixed mouse brain acquired in the two Tx configurations. A standard Fourier reconstruction in case A resulted in an image SNR of 29 (2A). In case B, which lacks Tx coil shielding, ghosting from the neighboring sample was high (2B) (48%, increased from 2% in A), but a SENSE-like reconstruction eliminated ghosting to less than detectable levels (2C). Interestingly, the SNR in case B was increased to 42, (45% higher than case A), possibly due to lower parasitic capacitances between the Rx coils and the Tx coils compared to configuration A. In case B, the large Tx coil showed a 6 fold reduction in available B_1 strength.

Conclusion

MMMRI with dedicated Rx coils can be achieved with two Tx coil configurations. A single Tx coil encompassing all samples, with proper reconstruction, provides excellent (possibly favorable) results for anatomical imaging where a strong B_1-field is not a required. Advantageously, it is possible to increase the number of samples imaged in this case by packing mice and Rx coils closer together.

Acknowledgments

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References

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