Multiple-Mouse Self-Gated Cardiac Cine MRI with Multiple Arrays of Receive Coils (MARCs)

E. Esparza-Coss[1], M. S. Ramirez[1], and J. A. Bankson[1]

[1]The Department of Imaging Physics, The University of Texas M. D. Anderson Cancer Center, Houston, TX, United States

Introduction

Simultaneous multiple-animal, self-gated cardiac cine MRI has been shown to drastically improve the imaging efficiency in small animal models of cardiac disease [1]. The reported technique involved an array of independent volume coils, dedicating one coil per animal. An aliased field strategy allowed single animal imaging parameters to be used in the simultaneous encoding of all animals after conveniently configuring the coil-array [2].

Here we propose that a further increase in imaging efficiency can be achieved by dedicating more than one receiver coil per animal as phased-arrays that enable increased acceleration factors and SNR while preserving the aliased field strategy in multiple-animal self-gated cardiac cine acquisitions.

The goal of this work was to demonstrate the feasibility to expand the multiple-mouse self-gated cardiac cine acquisition technique [1] using phased-array coils dedicated to each animal to allow various acceleration factors that increase imaging speed and SNR.

Materials and Methods

A dual-mouse imaging system (Fig. 1) was set on a 7.0 T Biospec MR scanner with a 30 cm bore (Bruker Biospin Corp., Billerica, MA). Two anesthetized mice were placed supine on a custom dual-mouse sled. Adjustable nose-cones supplying anesthesia were positioned as to have the hearts coaligned with the axial imaging plane. Respiratory monitoring was performed on a single animal for this proof-of-principle demonstration. A pair of two-element phased-array coils was designed to minimize coupling and improve the cardiac sensitivity over a volume coil. Each phased-array coil was placed onto the corresponding animal's heart and fixed onto the sled. Each array element was remotely tuned and matched. A transmit birdcage coil was used for excitation.

Self-gated cardiac cine data was acquired with a four-channel spoiled gradient echo pulse sequence developed to acquire navigator information before application of readout gradients. Readout was prescribed along the anterior-posterior dimension in one field-of-view (FOV) to preserve the aliased field strategy while the phase-encoding steps and FOV were reduced accordingly for one-, two, and three-fold acceleration factors. Axial full FOV images were acquired to derive the sensitivity maps required for sensitivity-encoded (SENSE) reconstruction.

Results

Figure 2 shows representative self-gated cardiac cine frames from one-fold accelerated acquisition. Images from each coil array element are displayed to show the difference in sensitivity across the coils. Signal averaging of 9 from over-sampled data was performed.

Discussion and Conclusion

A tradeoff between imaging speed and SNR is generally required when using phased-arrays. However, imaging speed may be preferred for self-gated cardiac imaging since the technique allows data to be averaged from over-sampled data. One-fold acceleration images were shown here to clearly demonstrate the different sensitivities in non-overlapping images. A simple sum of squares from these images could be applied to finalize the reconstruction from each mouse. For two- and three-fold accelerated acquisitions, SENSE reconstruction is to be performed. Multiple-animal self-gated cardiac cine MRI using phased-array coils to increase imaging speed and SNR is feasible.

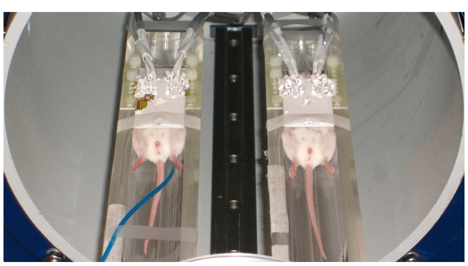

Fig. 1. Dual-mouse sled and coil system.

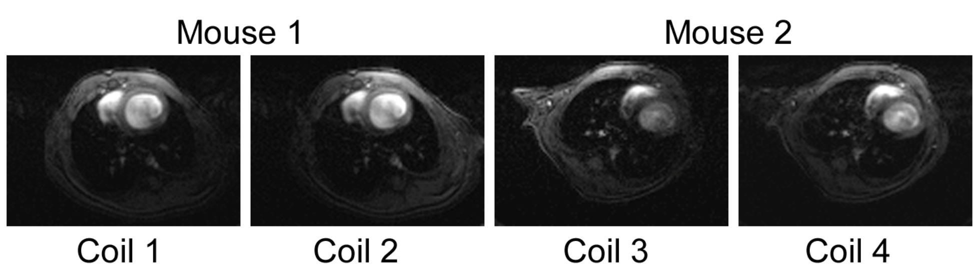

Fig. 2. Representative self-gated cardiac cine frames acquired through each of the four coils. Notice the different sensitivity regions from each coil in this non-accelerated acquisition.

References

[1] Esparza-Coss E, et al., Proc. 15th ISMRM, Berlin, p., 2007.

[2] Ramirez MS, Bankson JA. *J Magn Reson Imag* 26: 1162-1166, 2007.

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