Retrospective Gating for Whole Body Mouse MRI

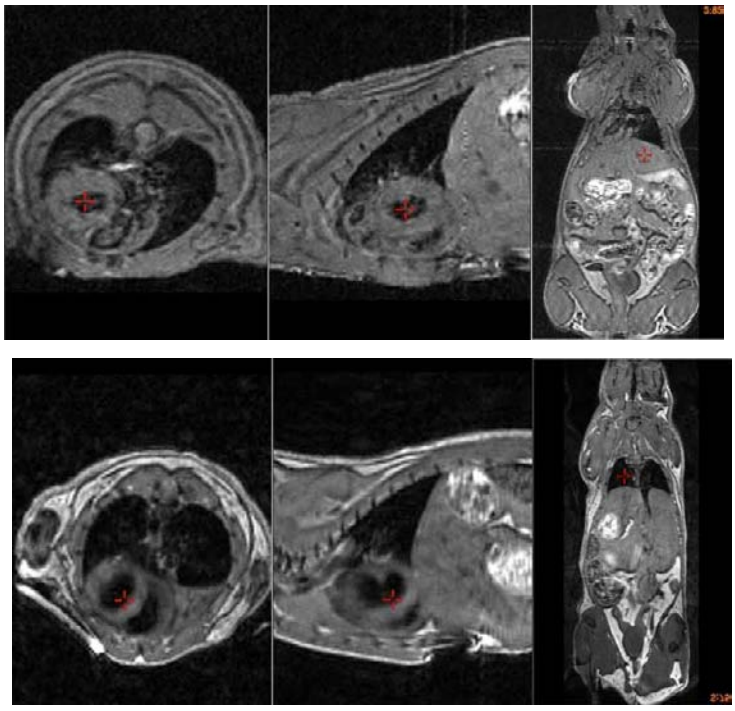
J. Bishop[1], L. Davidson[1], J. Dazai[1], and M. Henkelman[1,2]
[1]Hospital for Sick Children, Toronto, ON, Canada, [2]Medical Biophysics, University of Toronto, Toronto, ON, Canada

Introduction Multiple mouse magnetic resonance imaging has been introduced for high-throughput imaging of large numbers of mice [1]. The initial feasibility of this technique for cardiac imaging was studied and retrospective gating was shown to provide comparable image quality to prospective gating for three-dimensional imaging in mice [2]. In this abstract we extend the retrospectively gated method to whole body imaging and show that multiple mouse whole body imaging is feasible.

Materials and Methods Retrospectively gated reconstruction is based upon interpolation between measured data at arbitrary positions in the cardiac cycle and a set of fixed cardiac phases needed to construct a cine loop. In cine MRI, the cardiac RR interval is typically well-sampled using short TR gradient echo pulse sequences, and the interpolation error is thus minimized. In contrast, only one phase of the cardiac cycle is usually needed for whole body imaging. Therefore, data acquisition for retrospective whole body reconstruction can be limited to a small number of temporal samples per readout line, and correspondingly higher interpolation errors can be tolerated. As it has been shown that interpolation error in the cine MRI retrospective reconstruction problem is bounded [3], we can expect to obtain acceptable results with few temporal samples.

One normal mouse was anaestheized with isofluorane gas and imaged with a 7 Tesla MRI scanner (Varian NMR System, Palo Alto CA). The ECG and respiration were monitored with commercial hardware (SA Instruments Inc, Stoneybrook, NY), and recorded along with time stamp pulses from the scanner with a serial data acquisition board. Three-dimensional fast-spin echo imaging was performed with TR=325 msec, echo train length=6, echo spacing =6.6 msec and TE=6.6 msec. The data matrix was 432x144x144 to obtain a 200 μm isotropic voxel size. Each readout line was sampled five times for a total scan time of 90 minutes. In a second experiment, a mouse was prepared in a similar manner and scanned with conventional prospective gating on every second cardiac trigger. There were two signal averages for a total of 50 minutes of scan time.

As part of the retrospective reconstruction algorithm, readout lines corresponding to the gasping portion of the respiratory period were excluded, condensing the data set to 4 samples per readout line. Interpolation to the mid-point of the RR interval was performed with alternate pairs of lines. The resulting pair of interpolated lines was subsequently averaged to reduce the data set to a single time point per readout line, representing an effective number of averages of approximately four.



Results In the figure at right, the top row shows three orthogonal slices in the prospectively gated data set, while the bottom row shows three similar planes in the retrospectively gated data set. The retrospectively gated image is of very qood quality though it shows slightly poorer detail in the myocardium representing interpolation error. However, similar results could be expected in multiple mice without any additional scan time, whereas the scan time for prospective gating would scale in direct proportion to the number of mice.

Conclusions We have shown whole body images of a live mouse obtained with retrospective gating. The cardiac anatomy is reasonably well-depicted despite a very limited number of temporal samples, and respiratory artifacts are compensated equally well as with prospective gating. Retrospective gating can be used for whole-body multiple mouse MRI.

References

[1] Bock NA, Konyer NB, Henkelman RM. Multiple-mouse MRI. Magn Reson Med 2003; 49:158-167.
[2] Bishop J, Feintuch A, Bock NA, Nieman B, et al. Retrospective Gating for Mouse Cardiac MRI. Magn Reson Med 2006; 55:472-477.
[3] Roerdink JB, Zwann M. Cardiac magnetic resonance imaging by retrospective gating. Euro J Appl Math 1993; 4:241-270.