Fast Gated EPR Imaging of the Beating Heart: Spatiotemporally Resolved Wexner Medical Center Medical Zhiyu Chen, Levy A. Reyes, David H. Johnson, Murugesan Velayutham, Changjun Yang, Alexandre

Zhiyu Chen, Levy A. Reyes, David H. Johnson, Murugesan Velayutham, Changjun Yang, Alexandre Samouilov, and Jay. L. Zweier

Davis Heart and Lung Research Institute, Ohio State University, Columbus, Ohio, USA

ABSTRACT

vivo or ex vivo electron paramagnetic In resonance imaging (EPRI) is a powerful technique for determining the spatial distribution of free radicals and other paramagnetic species in living organs and tissues. However, gated EPRI was limited by long projection acquisition times and lack of signal to noise ratio. Hence in vivo EPRI typically provided only low temporal resolution. In order to achieve direct gated EPRI, a fast EPR acquisition scheme was developed to decrease the acquisition time of a single projection to 10 ms. Improvements in software and 20 instrumentation can now provide fast gated EPRI of the beating heart with sub-millimeter spatial resolution in as little as 2 to 3 minutes. Reconstructed images display the temporal and spatial variations of the free radical distribution, anatomical structure, and contractile function of a rat heart during the cardiac cycle.

INTRODUCTION

An important goal in fast gated EPRI is to achieve both high temporal and spatial resolution. Prior work with gated cardiac EPRI [1, 2] requires acquisition times of up to 2 hours and has been impractical for most physiological applications. A critical need of fast gated EPRI capable of completing an acquisition of an image sequence of the cardiac cycle within a few minutes. While spinning gradient [3,4] and rapid scan [5] improve acquisition speed, there is still further potential to accelerate the acquisition by improving the instrumentation and designing novel clocking schemes [6].

METHODS



Goal — Significantly reduce the amount of redundant data in waveforms by:

- 1. Heterogeneous clocking reduced D/A output clock rate and faster A/D input clock.
- Adaptive clock rate The A/D input clock rate is adjusted according to the magnetic field sweep time.





with supporting devices



Block diagram of a paced isolated heart with supporting devices



EXPERIMENTAL RESULTS



REFERENCES AND ACKNOWLEDGEMENTS

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CONCLUSIONS AND DISCUSSION

A fast gated EPRI acquisition technique was developed and applied to gated imaging of the cardiovascular disease in the isolated rat heart. This technique enables measurement and mapping of myocardial free radical concentration and metabolism as a function of the cardiac contractile cycle. Future work will include spectral-spatial measurements with high temporal and spatial resolution throughout the cardiac cycle.