Myocardial Viability Imaging using a Multi Half-echo Projection Reconstruction MR Technique

O. Unal[1], E. K. Brodsky[2], W. F. Block[1], T. F. Christian[3], T. M. Grist[4]

[1]Medical Physics, UW-Madison, Madison, WI, United States, [2]Biomedical Engineering, UW-Madison, Madison, WI, United States, [3]Cardiology, UW-Madison, Madison, WI, United States, [4]Radiology, UW-Madison, Madison, WI, United States

INTRODUCTION

T1-weighted post-contrast delayed-enhancement MR imaging is a promising technique to assess myocardial viability to predict which patients might benefit from revascularization [1-2]. Typically, the inversion time (TI) is set to null normal myocardium signal to increase the contrast between normal and infarcted myocardium. However, the TI to null normal myocardium signal varies from patient to patient and depends on the contrast dosage and the time elapsed since injection. A robust and fast technique that allows retrospective selection of TI to null normal myocardium would be beneficial [3].

MATERIALS AND METHODS

A 2D multi half-echo, cardiac-gated, angularly undersampled projection reconstruction-(PR)-based, segmented inversion-recovery MR technique for post-contrast myocardial viability imaging with improved data acquisition efficiency that allows retrospective selection of inversion time to null normal myocardium effectively by taking advantage of the intrinsic oversampling of the center of the k-space in PR acquisition and a sliding-window reconstruction technique with a temporally varying aperture with radial distance was developed. Sampling efficiency was doubled by acquiring data during dephaser, constant, rephaser gradients, and ramps during each TR.

All *in vivo* experiments were performed on a 1.5 T cardiac scanner (GE Medical Systems, Milwaukee, WI). The four half-echo pulse sequence and k-space trajectory are shown in Fig. 1a and 1b, respectively [4]. Projections are acquired in an interleaved fashion with typical scan parameters of TR/TE/Flip = 5.4 ms/1.6 ms/20-50°, FOV = 350 mm x 350 mm, slice thickness = 5 mm, and RBW = ±125 kHz, 64 projections, 8 projections per interleave. Depending on the heart rate, 10-20 cardiac phases are acquired in 8-12 heart beats. Typically 5 distinct sets of interleaved projections during each heart beat are repeatedly acquired. When an ECG trigger is detected, projection angle is incremented and new sets of interleaved projections are acquired. A sliding-window reconstruction scheme with a temporal aperture varying with radial distance (or Tornado filter) is used to combine data from several time frames in k-space to form final images.

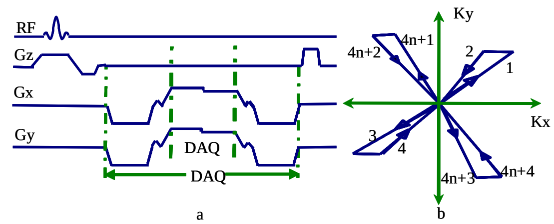

Figure 1. *The four half-echo pulse sequence and k-space trajectory are shown in (a) and (b), respectively. Data is acquired during ramps as well.*

RESULTS AND DISCUSSION

Figure 2 shows short axis images of a monkey heart with myocardial infarct. Each image corresponds to a different inversion time and was reconstructed using data from 5 time frames. Eleven cardiac phases were acquired in 13 seconds. The temporal aperture is 22 ms. The sampling efficiency doubled by acquiring data during dephaser, constant, and rephaser gradients as well as ramps during each TR can be utilized either to shorten scan time or improve SNR / CNR for a fixed scan time. Shorter scan times achieved with this improved acquisition technique should make breathholding more tolerable. In addition, sampling the center of k-space multiple times during each TR leads to reduced fat sensitivity as seen in the images.

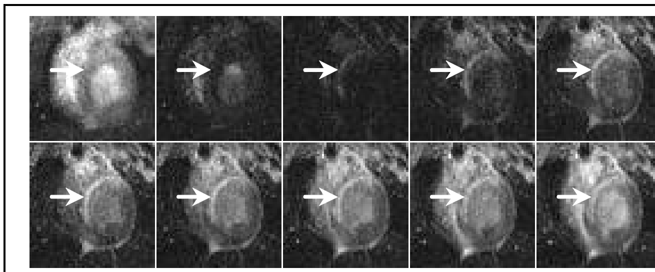

Figure 2. *Short axis images of a monkey hearth with myocardial infarct. Each image with different normal myocardium signal nulling corresponds to a different inversion time.*

CONCLUSIONS

Our initial results suggest that the 2D multi half-echo cardiac-gated PR-based inversion-recovery technique allows retrospective selection of inversion time for optimal nulling of normal myocardial signal. The method can be an attractive alternative for myocardium viability imaging as well as wall motion abnormalities.

REFERENCES

1. Kim RJ, *et al*., *NEMA,* **343**, 1445, 2000.
2. Simonetti OP, *et al*., *Radiology,* **218**, 215, 2001.
3. Unal O, *et al*., *Proc. Eleventh ISMRM*, 1604, 2003.
4. Lu A, *et al*., *Proc. Eleventh ISMRM*, 210, 2003.