Myocardial Viability Imaging using HYPR-based MRI Techniques

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INTRODUCTION

Assessing myocardial viability in patients with coronary artery disease and left ventricular dysfunction can be critical to determine which patients might benefit from revascularization [1]. Delayed-enhancement MR imaging (DE-MRI) has shown promise in distinguishing healthy myocardium from infarcted myocardium since infarcted myocardium exhibits higher signal than normal myocardium [2-3]. However, the selection of optimal inversion time (TI), which depends on contrast dosage and also varies from patient to patient, to null normal myocardium signal greatly affects the diagnostic value. Therefore, a fast MRI technique that allows retrospective selection of TI to null normal myocardium would be advantageous. Here, we have investigated the potential of HYPR-based DE-MRI techniques [4-5] for 2D / 3D myocardial viability imaging to allow retrospective selection of inversion time (TI) for nulling normal myocardial signal.

MATERIALS AND METHODS

2D PR and 3D stack-of-stars, ECG-gated, inversion recovery (IR) prepared steady-state-free precession (SSFP) techniques were implemented and used on a 1.5 T scanner for delayed-enhancement MR imaging of myocardial viability in animal and human subjects following contrast injection. Angular projection data were acquired in an interleaved fashion [3]. Typical scan parameters were TR/TE/Flip = 3.9 ms/1.4 ms/40°, FOV = 320 mm x 320 mm, and RBW = ±62.5 kHz, 4-8 projections per interleave were acquired. Images reconstructed using standard filtered backprojection (FBP), two HYPR techniques [4-5], and temporal Tornado filter [6] were compared to evaluate image quality and temporal waveform fidelity.

RESULTS AND DISCUSSION

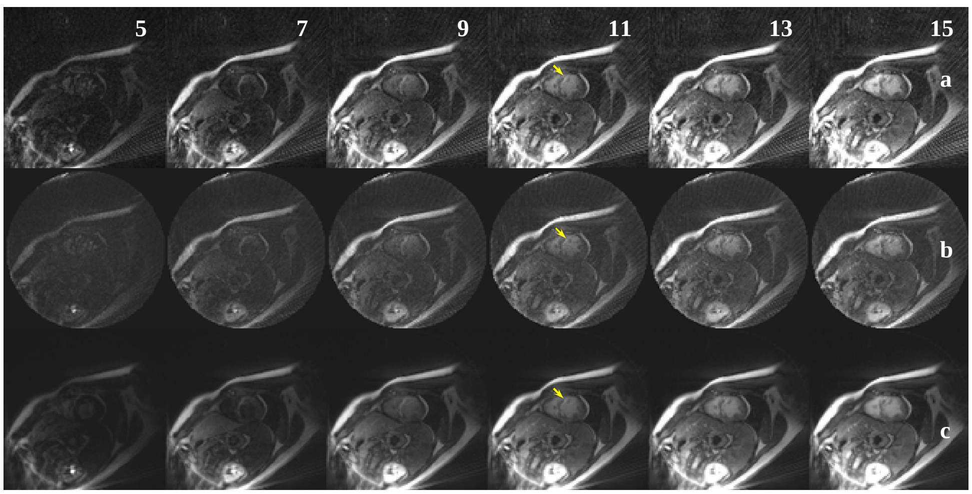

Figure 1: Comparison of myocardial viability results obtained with a 2D PR DE-MRI technique. Images reconstructed using a) FBP with 48 projections/single time frame, b) Tornado filter combining 5 time frames, and d) HYPR employing 5- time-frame composite images.

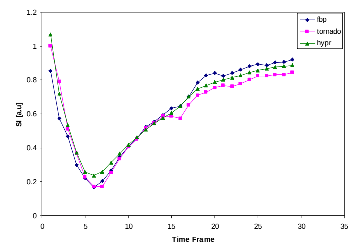

Figure 2: Temporal characteristics in left ventricle obtained with FBP, Tornado filter and HYPR.

Figure 1 shows temporal short-axis delayed enhancement images reconstructed with a) FBP, b) Tornado filter, and c) HYPR of a patient with myocardial infarct obtained during 12 heart beats. Each image corresponds to a different inversion time. The yellow arrows in the images (time frame 11) corresponding to the optimal myocardium suppression points to an infracted region of myocardium. The FPB images were reconstructed using 48 projections (or single time frame data). The HYPR algorithm used 5-time-frame sliding-window composite images to constrain the reconstruction of individual time frames. The temporal resolution of time series was not compromised since the backprojection was performed using single time-frame *k*-space data. The Tornado images were reconstructed using data from 5 time frames (100 % of the data obtained at time t, 75 % of the data (higher spatial frequencies) obtained at time frames (t – 1) and (t + 1), and 25 % of the data (highest spatial frequencies) obtained at time frames (t – 2) and (t + 2). Compared to the FBP and Tornado images, the HYPR technique provides relatively artifact-free images with higher SNR.

To evaluate the temporal accuracy, the signal-intensity-time curves in the left ventricle (LV) obtained using each technique are shown in Figure 2. As clearly seen from the figure, images reconstructed using HYPR and Tornado clearly demonstrate the temporal characteristics of the LV cavity and is in good agreement with that of FBP. These preliminary results indicate that, with appropriately selected MR acquisition parameters, a HYPR time series can provide images corresponding to different inversion times and convey the temporal dynamics with good fidelity that may offer advantages to study wall motion abnormalities.

CONCLUSIONS

Our preliminary results suggest that, compared to FBP and Tornado filter, HYPR-based techniques may offer advantages for myocardial viability imaging by providing relatively artifact-free images with high temporal resolution to allow retrospective selection of inversion time (TI) to differentiate infarcted from healthy myocardium. Shorter scan times achieved should also make breath-holding more tolerable.

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