Rotational Long Axis Stress Myocardial Perfusion Imaging

Y. Wang[1,2], S. A. Siddiqi[1], S. T. Mathew[1], N. Ngai, PhD[1], O. Akinboboye[1,3], N. Reichek[1,3]

[1]Research and Education, St. Francis Hospital, Roslyn, NY, United States, [2]Biomedical Engineering, State University of New York, Stony Brook, NY, United States, [3]Medicine, State University of New York, Stony Brook, NY, United States

INTRODUCTION

High quality short axis perfusion imaging of true apical and basal myocardium is quite challenging due to both their remote location relative to surface coils and fatty tissue induced field inhomogeneity. Additionally, through-plane motion and differences in the temporal location of each slice in the cardiac cycle limit the myocardial area covered in perfusion imaging. First pass perfusion imaging in rotational long axis (RLA) has been shown to provide a better deliniation of apical and basal myocardium and to increase the myocardial area covered by one third (1). In this study, we apply this technique to clinical patients undergoing pharmacologic stress perfusion and validate its performance against nuclear SPECT imaging.

MATERIAL AND METHODS

Fourteen (ages: 52 to 80, 5 females) clinical patients with chest pain who were referred for nuclear SPECT testing were consented for additional MR stress perfusion study and enrolled after IRB approval. The study was done on a 1.5 T Siemens Sonata scanner (Siemens Medical Solutions, Malvern, PA). Three RLA slices were prescribed as HLA, VLA, and LVOT view of the left ventricle, all perpendicular to a middle ventricular short axis slice. A partial Fourier saturation recovery TrueFISP sequence was used with following typical parameters: TR/TE/TI/FA = 2.9ms/1.3ms/90ms/50°, data matrix 90×192, and voxel size 1.9×2.8×8 mm^3. After obtaining scout images, adenosine (Fujisawa Healthcare, Inc. Deerfield, IL) was injected at 140 μg/kg/minute for 6 minutes. After 3 minutes of adenosine infusion, breath-hold first-pass perfusion imaging was obtained over 50 cardiac cycles with data acquisition starting two cardiac cycles prior to administration of contrast agent (0.05 mM/kg/injection at 6 ml/sec, Omniscan, Nycomed, Princeton, NJ). A resting perfusion series was then collected at the same slice location with a 20 minutes washout period between contrast injections. MASS (Medis, Leiden, the Netherlands) was used to manual trace the endo- and epi-myocardial contours and obtain the mean contrast dynamic signal of six myocardial segments on each slice. The regional flow reserve (FR) for 18 segments of each patient was evaluated as the ratio between stress and rest perfusion value from a Fermi model in a Matlab program. Attenuation-corrected gated nuclear SPECT stress-rest imaging was performed on the same day with approximately 30mCi of ^{99m}Tc. The stress dose was injected in the third minute of adenosine infusion while patient was in the MRI scanner. MR quantification results and clinical nuclear findings were both mapped to the AHA recommended 17-segment myocardial model. The MR FR values in sectors with (SPECT +) and without (SPECT −) a perfusion defect on qualitative analysis were compared.

RESULTS

Long axis perfusion images obtained during both stress and rest demonstrated good image quality and contrast between myocardium and blood and excellent depiction of the most apical and most basal myocardium, as shown in all 3 RLA slices at contrast arrival in the left ventricle (**Figure 1**). The gated SPECT imaging was normal in 7 patients. The FR for a total of 231 myocardial sectors was analyzed (after 7 sectors were excluded due to susceptibility or flow artifacts.). The mean and standard deviation for perfusion FR was 2.33±1.46 in normal sectors versus 1.14±0.74 in sectors with perfusion abnormality (as summarized in **Table 1**), and the difference of the means is statistically significant ($F=20.31$, $p<0.0001$) after adjusted by patient and SPECT + or − using three-way ANOVA.

CONCLUSION AND DISCUSSION

Rotational long axis stress perfusion imaging is easy to implement, provides robust perfusion reserve data in the expected range and provides excellent depiction of apical and basal myocardium. Our study shows that myocardial flow reserve measured by MRI using the Fermi model, clearly separates those myocardial sectors with and without a SPECT perfusion defect.

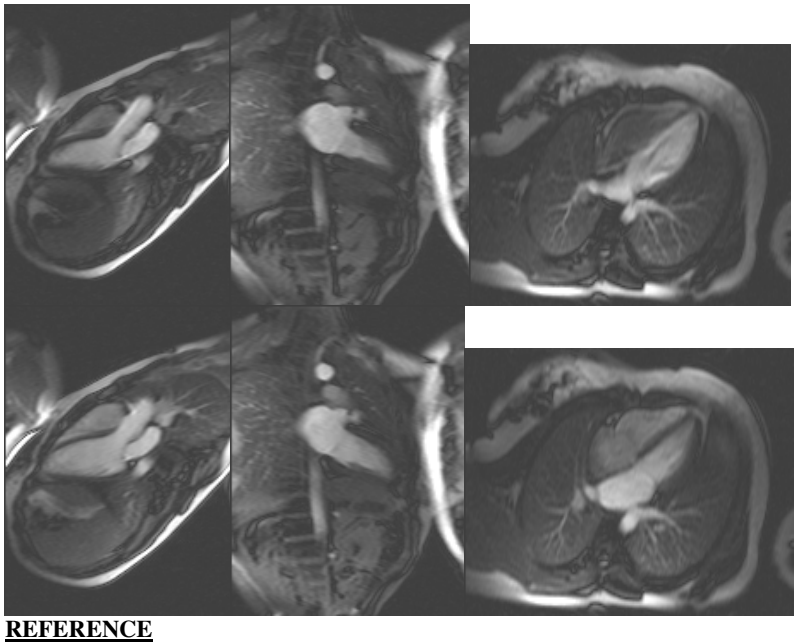

Table 1 MR regional coronary flow reserve classification according to nuclear SPECT

classification	n	mean	SD
Flow reserve SPECT +	15	1.14	0.74
Flow reserve SPECT –	216	2.33	1.46

Figure 1 (left). Long axis perfusion images at stress (upper panel) and rest (lower panel) when contrast reaches ventricles shows nice true basal and apical myocardium.

REFERENCE

(1). Y. Wang *et al*, Myocardial first-pass perfusion assessment using rotational long-axis MRI, JMRI. 2005 Jul;22(1):53.

(2). M. Jerosch-Herold, *et al,* Magnetic resonance quantification of the myocardial perfusion reserve with a Fermi function model for constrained deconvolution, Med Phys. 1998 Jan; 25(1): 73.