Journal of Cardiovascular Magnetic Resonance

Poster presentation

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Arterial spin labeled MRI detects increase in myocardial blood flow with adenosine

Zungho Zun*[1], Padmini Varadarajan[2], Raas G Pai[2], Eric C Wong[3,4] and Krishna S Nayak[1]

Address: [1]University of Southern California, Los Angeles, CA, USA, [2]Loma Linda University Medical Center, Loma Linda, CA, USA, [3]University of California, La Jolla, CA, USA and [4]University of California, San Diego, La Jolla, CA, USA

* Corresponding author

from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):P209 doi:10.1186/1532-429X-12-S1-P209

This abstract is available from: http://jcmr-online.com/content/12/S1/P209

Introduction

Myocardial arterial spin labeling (ASL) is an emerging technique for the assessment of myocardial perfusion. ASL does not require any contrast agents, and therefore can be used in patients with renal failure. We recently demonstrated feasibility of myocardial ASL [1]. In this study, we applied myocardial ASL to measure increased MBF during adenosine infusion.

Methods

Eleven patients were recruited, among those scheduled for routine cardiac MRI. All experiments were performed on a GE Signa 3 T scanner. Myocardial ASL measurements were obtained from a single mid short-axis slice, using flow-sensitive alternating inversion recovery (FAIR) tagging and balanced steady-state free precession (SSFP) imaging [1]. In each patient, one or two scans were performed at rest, and one scan was performed during adenosine infusion (dosage: 0.14 mg/kg/min). All patients also underwent first-pass perfusion imaging before adenosine infusion stopped (Table 1).

Table 1: Excerpt from the imaging protocol

3 min	"Rest" ASL scan
3 min	"Rest" ASL scan
	Begin Adenosine Infusion
2 min	Wait
3 min	"Stress" ASL scan
1 min	"Stress" First-Pass Perfusion
	End Adenosine Infusion

Results

CMR first-pass images were read by two experienced cardiologists, and resulted in seven of the eleven subjects classified as "normal", based on having no visible perfusion defects. Fig. 1 contains the average MBF measurements of six myocardial segments (each segment size = 1.5 ± 1.0 cm^3) from ASL in these "normal" subjects. The average MBF across subjects was 1.09 ± 0.53 ml/g/min at rest and 3.75 ± 1.06 ml/g/min during adenosine infusion, showing 4.97 ± 4.64 times increase. The increase in MBF was statistically significant ($P < 0.001$, t-test).

Discussion

The adenosine-induced MBF increase in normal myocardium has been documented to be 4.00 ± 1.10 times based on ^{15}O-H_2O PET [2]. The present study has demonstrated that myocardial ASL is able to capture these dramatic MBF changes. This study is on-going, and as we obtain more subjects with angiographically-significant disease and/or perfusion defects on first-pass imaging, we will be able to evaluate the ability of rest-stress myocardial ASL to detect perfusion defects. Fig. 2 contains segment-based MBF measurements using ASL and coronary angiogram from our first patient with single-vessel disease. Lowered MBF increase on anterior wall may be due to total occlusion of left anterior descending (LAD) artery.

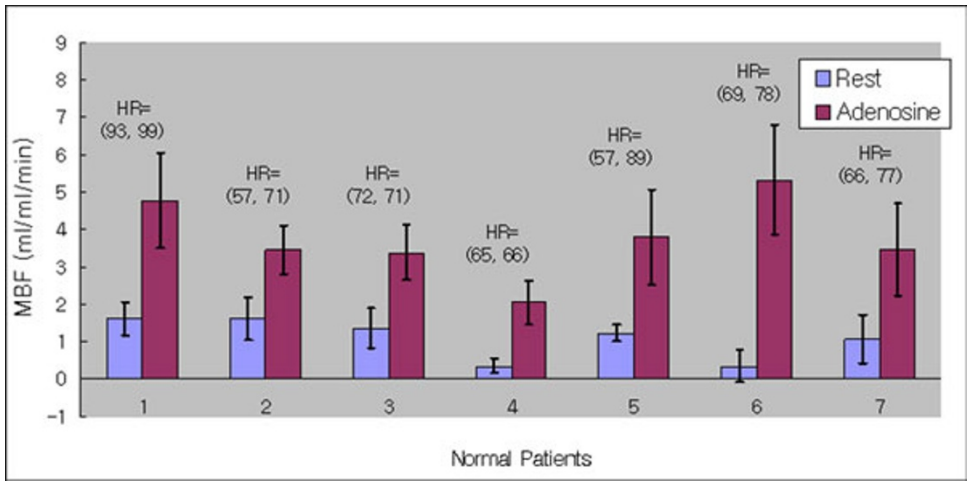

Figure 1
MBF measurements using ASL and heart rates (HR, in bpm) at rest and during adenosine infusion, from "normal" patients.

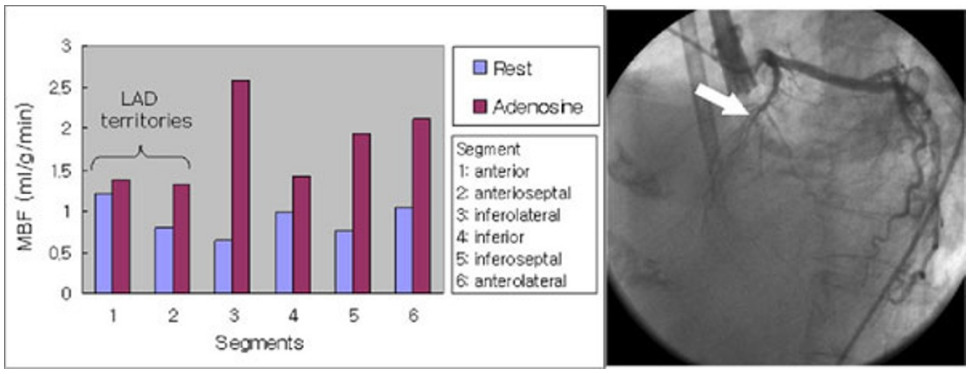

Figure 2
Left: MBF measurements using ASL for each myocardial segment. Right: Coronary angiogram with total LAD occlusion (arrow) from the same patient.

References

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