Detection of Coronary Artery Disease with both Myocardial Blood Flow and Volume:

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Purpose

Both myocardial blood flow (MBF) and myocardial blood volume (MBV), quantified by myocardial contrast echocardiography (MCE), have shown the ability to provide important information on coronary artery diseases [1]. Recently, we have developed fast mapping techniques for quantifying both perfusion parameters with a MRI first-pass dynamic imaging method [2-4]. The purpose of this study is to evaluate these techniques in the assessment of changes in MBF and MBV that occur with differing severities of coronary artery stenosis during Dipyridamole or Dobutamine induced hyperemia.

Table. Dog groups and results.

Group (*n*)	Stenosis (Area)	Hyperemia	MBF		MBV	
			LAD	LCX	LAD	LCX
1 (14)	normal	Dipyridamole	148%	187%	43%	50%
2 (4)	normal	Dobutamine	179%	194%	40%	56%
3 (4)	70%	Dipyridamole	29%	185%	19%	31%
4 (3)	90%	Dipyridamole	13%	136%	25%	50%
5 (3)	50%	Dobutamine	55%	145%	69%	46%
6 (3)	70-90%	Dobutamine	40%	126%	25%	20%

Methods

Thirty-one dogs were divided into six groups (Table). Stenosis was created by using an MR-compatible occluder in the proximal left anterior descending coronary artery (LAD) in an open-chest model. MR first-pass perfusion scans were performed at rest and during the pharmacologically induced hyperemia for all dogs. Gadomer (Schering Pharma AG, Berlin), an intravascular contrast agent, was injected (0.015 mmol/kg) as a bolus during each scan. Images were pre-denoised with a wavelet method [2], and a validated perfusion quantification method designed in our lab [3] was applied to obtain MBF (Figure 1) and MBV maps. Data from both LAD perfused anterior and left circumflex (LCX) perfused inferior myocardial beds were determined.

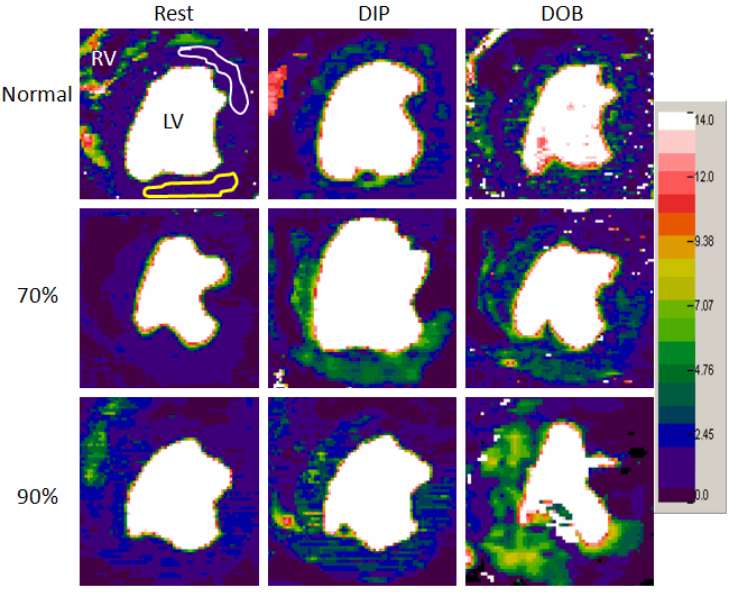

Figure 1. MBF maps from different dogs. Short axis images showing the left ventricle (LV), right ventricle (RV), and myocardial ring with example ROIs in the LAD bed (white) and LCX bed (yellow). Scale values in ml/min/g.

Results

The percentage changes of MBF and MBV after hyperemia are presented in the Table. Myocardial blood flow and volume reserve (MFR and MVR) are also presented in Figure 2. In normal dogs, both Dipyridamole and Dobutamine generally have a similar effect on MBF and MBV. In physiologically significant stenotic dogs during either vasodilator (Dipyridamole) or inotropic stress (Dobutamine), there was a coupling between decreased MBV (capillary derecruitment) and hyperemic MBF, confirming the role of capillary resistance in the regulation of hyperemic MBF [5]. Interestingly, both reserves in the remote normal LCX region decreased with stenosis severity as well, which agrees with other studies [6-7]. Furthermore, Dobutamine-stress produced a slight increase in blood volume reserve with 50% stenosis in the LAD region (Figure 3). This may reflect adaptive auto-regulation, but further study is needed on this observation.

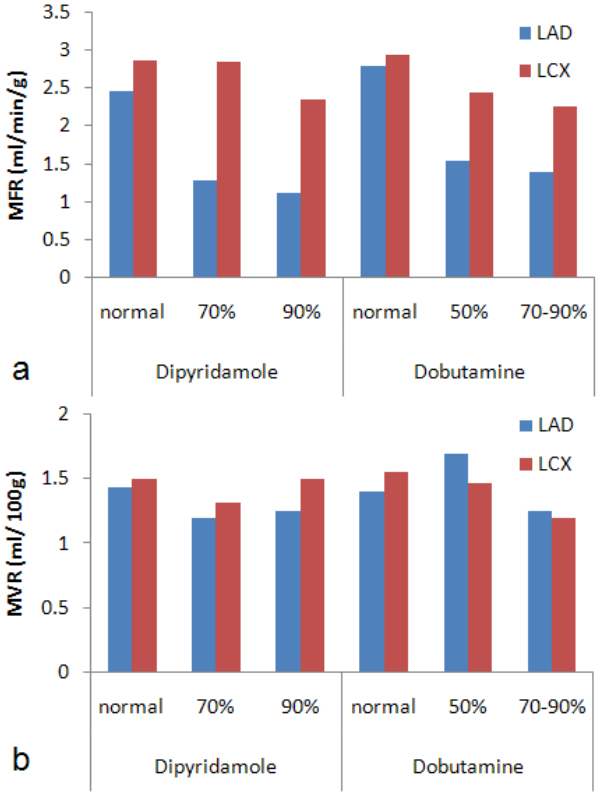

Figure 2. Myocardial flow reserve (a) and volume reserve (b) during Dipyridamole or Dobutamine for varying stenosis severities.

Conclusions

First-pass perfusion MR allows for fast quantification of MBF/MBV changes in a setting of coronary artery stenosis. Measurements of both MBF and MBV may allow for more comprehensive diagnoses and better treatment planning.

References

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