Journal of Cardiovascular Magnetic Resonance

BioMed Central

Meeting abstract

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1090 Black-blood myocardial T2 and oxygenation imaging using a diffusion-weighted prepared sequence

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from 11th Annual SCMR Scientific Sessions
Los Angeles, CA, USA. 1–3 February 2008

Published: 22 October 2008

Journal of Cardiovascular Magnetic Resonance 2008, **10**(Suppl 1):A215 doi:10.1186/1532-429X-10-S1-A215

This abstract is available from: http://jcmr-online.com/content/10/S1/A215

Introduction

We have recently shown that blood-oxygen-level-dependent (BOLD) T2-weighted images can determine the myocardial oxygen extraction fraction (OEF) during hyperemia [1,2]. This method works well using a double-inversion-recovery-pulse (DIR) prepared black-blood sequence. However, when irregular EKG-triggering or arrhythmias occur, for instance, during Dobutamine hyperemia, it is difficult to adequately suppress blood signal. The purpose of this study is to evaluate another black-blood imaging technique, a so called diffusion-weighted (DW)-prepared sequence [3], for its capability to determine the myocardial T2 and then quantify OEF in a stenotic dog model.

Methods

Eight dogs were divided into three groups (Table 1). Stenosis was created using an occluder in the proximal left anterior descending coronary artery (LAD) in an open-chest model. Myocardial black-blood T2-weighted images were acquired using a 2-D segmented DIR prepared turbo spin-echo (TSE) sequence. DW prepared T2-weighted images were collected with optimized sequence parameters. These sequences were performed several times during rest, and during either Dipyridamole or Dobutamine-induced hyperemia. Using a two-compartment model [1], hyperemic OEF can be determined [1]. Rest OEF was assumed to be 0.6, which is based on OEF values measured in normal dogs using an arterial and coronary sinus blood sampling approach at rest [1]. It is assumed that this value changes little with moderate stenosis [4,5]. In addition, MBV values, both at rest and during hyperemia, were determined with a quantitative first-pass perfusion CMR method. Regional T2 and MBV values were determined in the stenotic LAD subtended region and the remote normal left-circumflex (LCX) subtended region. Both data were used in the model to calculate regional OEF during hyperemia. The SNR values of the T2-weighted images were measured as well for comparison studies.

Results

Overall, there was no significant difference in the T2 values obtained by DW and DIR methods; although DW slightly underestimated the DIR T2 (Figure 1). This resulted in a non-significant difference in regional myocardial OEF between the two methods (Figure 2). When looking into specific groups, there is one group in which the DW OEF does significantly differ from the BOLD-determined OEF value (Figure 3). The group 3 dogs with

Table 1: Dog groups

Group (*n*)	Stenosis	Stressor
1 (2)	90%	Dipyridamole
2 (3)	50%	Dobutamine
3 (3)	70–90%	Dobutamine

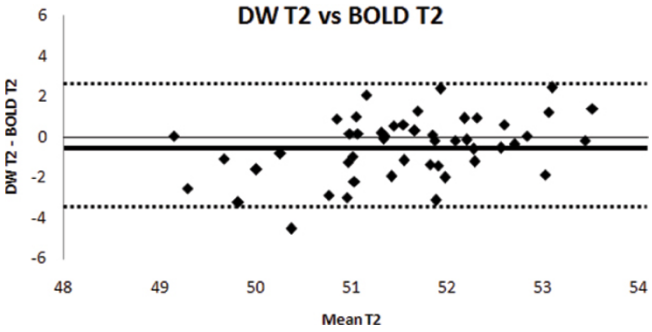

Figure 1
Bland-Altman plot of DWT2 vs DIR T2.

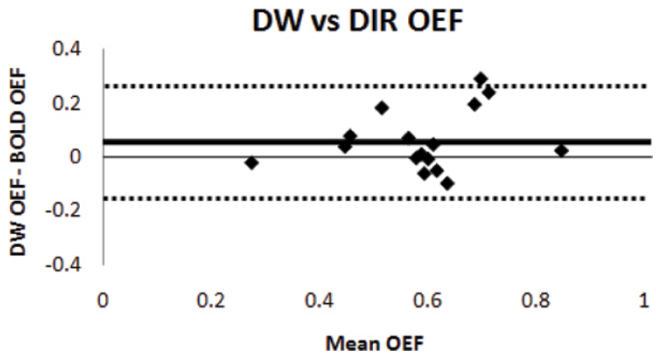

Figure 2
Bland-Altman plot of DW OEF vs. DIR OEF.

70–90% stenosis during Dobutamine hyperemia showed a difference in regional OEF between the DW and DIR methods. Severe stenosis and increased heart contractility in this group of dogs lead to highly irregular heart rhythms. The OEF derived from the DW method seems to agree with the traditional wisdom that in the critical stenotic region, limited blood flow supply leads to an increase in OEF due to the elevation of contractile demand (i.e., increase in MVO_2). In the normal region, one would expect the increase in blood flow to approximately match the increase in MVO_2, resulting in no significant change in OEF. Figure 4 shows examples of myocardial T2-weighted images with both black-blood methods.

The disadvantages of the DW method are the lower SNR (6.6 ± 2.1%) compared with DIR images, as well as an increased sensitivity to the magnetic shimming.

Conclusion

The DW imaging method appears to perform well or better for the quantification of OEF, despite lower SNR. In clinical practice, adding DW prepared sequences in car-

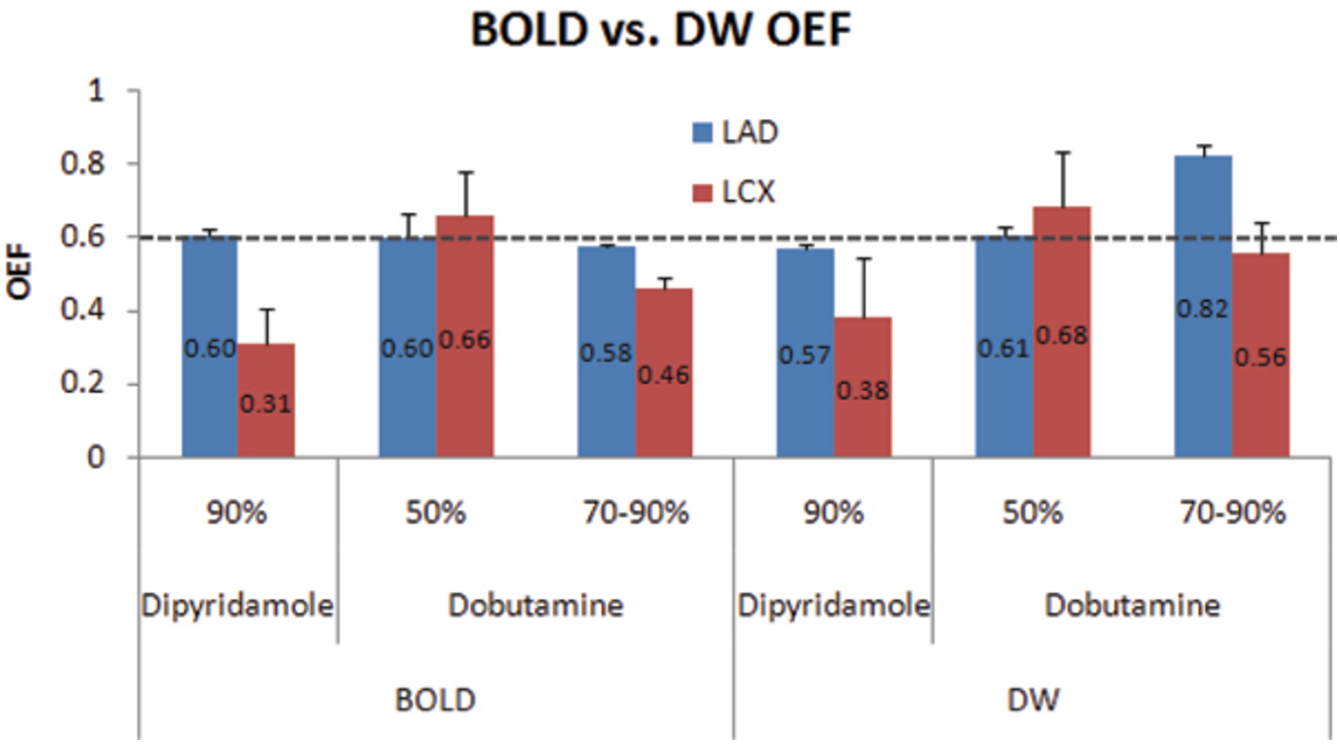

Figure 3
DIR and DW OEF during hyperemia with various stenosis degrees. The dotted line shows the assumed rest OEF of 0.6.

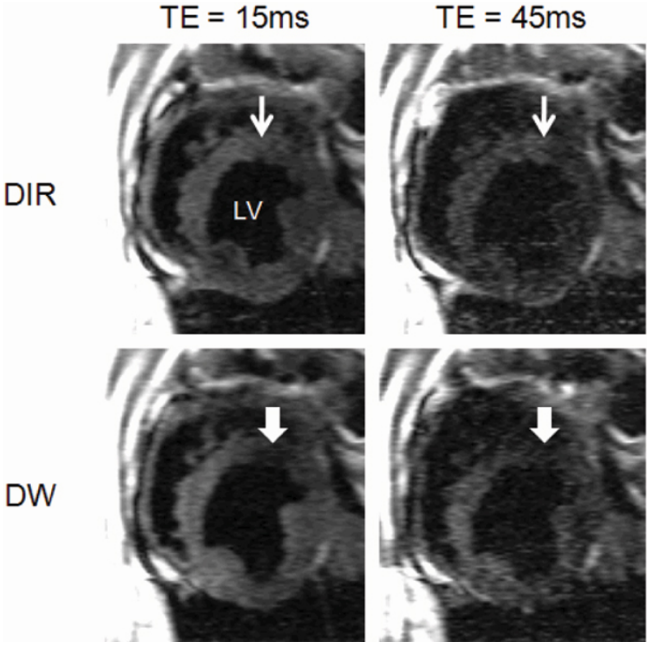

Figure 4
Comparison of DIR and DW prepared T2-weighted images during Dobutamine hyperemia in a LAD stenotic dog. Although blood signal in the left ventricle appears to be suppressed, the irregular ECG triggering and fast heart beats (~180/min) resulted in "spillover artifacts" from unsaturated blood signals, as shown in the anterior regions of DIR images (hyperintensity, arrows). In contrast, DW images demonstrate the expected lower signals in the anterior regions (block arrows) resulting from 90% LAD stenosis. LV = left ventricle.

diac CMR protocols may provide quality black-blood images when irregular ECG-triggering or arrhythmias is presented.

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