Reproducible coronary vessel wall imaging at 3T using improved Motion Sensitized Driven Equilibrium (iMSDE).

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Introduction:

The currently used standard for coronary vessel wall imaging is based on a 'black-blood' double inversion recovery (DIR) prepulse which nulls the blood in the coronary artery while the coronary artery wall is depicted with high signal[1,2]. The major drawback of this technique, however, is the relatively long inversion time needed for sufficient blood nulling. As a result, imaging of a single coronary artery may take up to 10-15 minutes. Furthermore, the DIR technique is known to suffer from slow flow artefacts as it requires full blood replenishing to achieve blood suppression. A recently developed improved motion sensitized driven equilibrium (iMSDE) technique can provide blood suppression within a relatively short preparation time[3]. The purpose of our study was to investigate the reproducibility of the iMSDE technique for MR imaging of the human coronary vessel wall.

Materials and methods:

The study group consisted of 10 young (8 males; mean age 25 ± 4.7 years (mean ± standard deviation) and 9 elderly volunteers (7 males; mean age 59 ± 9.2 years). Informed consent was obtained from all participants. Subjects underwent bright blood MRI of the right coronary artery (RCA) lumen followed by an iMSDE vessel wall scan in the same orientation according to a previously optimized protocol[4]. Imaging parameters of the iMSDE sequence are: TR/TE 10/2.3 ms, flip angle 20°, TFE factor 19, FOV 300×264×30mm, resolution 0.9×0.9×1.5mm. After the first scanning session was complete, patients were taken out of the magnet and off the scanner table. Subsequently, a similar second session was initiated within 15 minutes after completion of the first. For analysis, the RCA was divided in 3 segments: the proximal, middle and distal RCA. From the data-sets of both scanning sessions, lumen diameter was measured on bright blood luminography and the iMSDE sequence. In each RCA, 1 to 3 segments were measured depending on the length of visualization. Wall thickness measurements were performed on the iMSDE images in 2 regions of interest per segment. For lumen diameter measurements, 37 segments were available on bright blood luminography and 21 on iMSDE. On iMSDE, 52 wall thickness measurements were available for analysis.

Results:

In 15/19 volunteers two measurements of both the coronary lumen and the vessel wall were acquired successfully. 4/19 subjects were excluded for analysis because incompleted second acquisition due to persistent problems with erratic vectorcardiogram signal (n=2) or poor vessel wall scans image quality for further evaluation caused by arrhythmia (n=2). Results of the reproducibility of lumen diameter and wall thickness measurements are listed in Table 1. Figure 1 and 2 show images of 2 volunteers and demonstrate good reproducibility of both bright blood coronary MRI and the iMSDE vessel wall sequence.
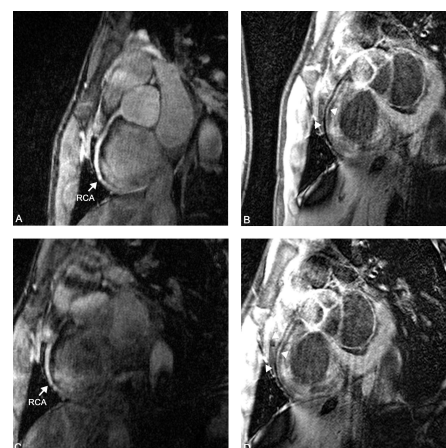
Reproducibility of Lumen Diameter and wall thickness measurements						
Sequence	Location	Measurement 1 (mm ± SD)	Measurement 2 (mm ± SD)	P-value	Correlation Coefficient R^2	P-value (ANOVA)
Bright Blood	Lumen (n=37)	3.45 ± 0.94	3.45 ± 0.89	0.99	0.81	<0.001
Black blood (iMSDE)	Lumen (n=21)	2.11 ± 0.70	1.78 ± 0.39	0.10	0.04	0.375
Black Blood (iMSDE)	Vessel wall (n=52)	1.16 ± 0.59	1.17 ± 0.55	0.81	0.63	<0.001

Table 1. Reproducibility of bright and black blood lumen diameter measurements as well as black blood wall thickness measurements (in mm ± SD) in the right coronary artery.
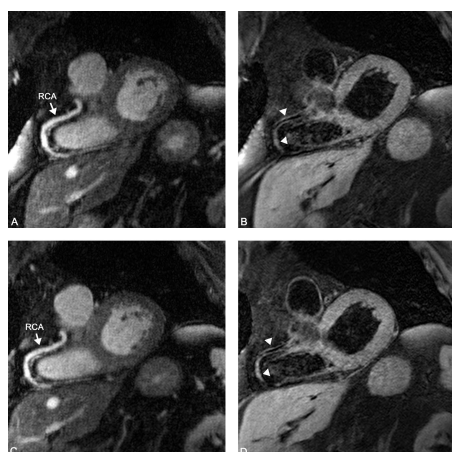
◄Figure 1. Bright blood luminography (A,C) and iMSDE vessel wall scan (B,D) of the right coronary artery (RCA) in a 76 y/o male. A and B represent images from the first session, C and D were acquired in the second scanning session. Note the good correlation between both scans for visualization of the RCA and the vessel wall (arrowheads).

►Figure 2. Bright blood luminography (A,C) and iMSDE vessel wall scan (B,D) of the right coronary artery (RCA) in a 23 y/o male. A and B represent images from the first session, C and D were acquired in the second scanning session. Again there is a good correlation between both scans for visualization of the RCA and the vessel wall (arrowheads).

Conclusions:

This study demonstrated that iMSDE is able to visualize the coronary vessel wall of healthy volunteers at 3T with good reproducibility of lumen diameter and wall thickness measurements. Further studies in patients are underway.

References:

1 Botnar et al. MRM 2001 46:848-854   3 Wang et al. MRM 2007 58:973- 981
2 Kim et al. Circ 2002 106:296-299   4. Wang et al. ISMRM 2009 #1895