Preliminary Results in Coronary MRA at 3 Tesla using TFE and balanced-TFE Sequences

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Introduction

At 1.5 Tesla free breathing navigator gated balanced-TFE (TrueFISP, FIESTA) sequences for coronary MRA are state of the art due of the excellent contrast between blood and myocardium. Preliminary results show the feasibility of coronary MRA with TFE sequences at 3 Tesla [1]. This study confirms these findings at 3T and compares TFE and b-TFE coronary MRA.

Material & Methods

Measurements were performed on a clinical whole-body MRI scanner (Intera 3.0T Philips Medical Systems; 30mT; 150 mT/m/ms; Release 10.3) in combination with a vector-ECG and a 6-element-cardiac-synergy-coil. 11 healthy volunteers (average age 29, female and male) were investigated.

A breathhold scout was acquired, followed by a reference scan for using homogeneity correction (CLEAR). By applying a transverse cine multi phase heart scan at the level of the right atrium in breathhold technique the systolic and diastolic rest periods of the right coronary artery (RCA) were analyzed, defining the trigger delay for the following free breathing scans. The navigator pencil-beam was placed on the dome of the right hemi-diaphragm and a gating window of 5mm was used. To decrease the off-resonance sensitivity of the pencil-beam the number of turns in k-space was reduced from 16 to 9 and the beam radius increased from 30mm to 40mm. As a high resolution scout a transverse 3D volume was acquired by a 3D gradient echo planar imaging (TFE-EPI) sequence (45 slices). A constant motion correction factor of 0.6 in feet-head direction was used for prospective respiratory motion compensation [2].

Scans were planed separately for the right and left artery system (RCA and LM/LDA) using the 3 point plan scan tool. For data acquisition two 3D fat suppressed sequences with a FOV of 270mm and 20 slices were applied. The first sequence was a TFE (TR=6ms;TE=3ms;α=20°; FOV=270x270mm^2, Matrix 384x269, Slice thickness 3mm, 10 slices), the second a balanced-TFE (TR=5.8ms, TE=2.9ms, α=60°, FOV=270x270mm^2, Matrix 272x272, Slice thickness 3mm, 10 slices). The turbo factor was adjusted patient-specifically on the rest interval of the coronaries (acquisition time of 60-70ms).

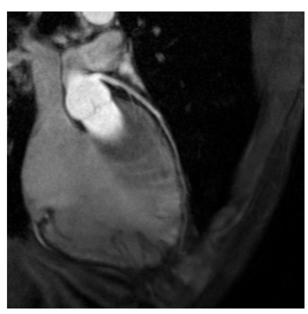
The acquired images were independently evaluated by two experienced radiologists in a blinded manner. According to the American College of Cardiology/American Heart (ACC/AHA) a segmentation scheme was applied [3]. The RCA was subdivided into three segments, the LM,LAD into four. After segmentation the visibility of each coronary segment was graded in 2 grades (0=not visualized, 1=visualized). With an interactive tool (“soap-bubble-tool” [4]) the vessel length was measured. The signal intensities (S) and standard derivations (σ) for blood and muscle were obtained by setting regions of interest (ROI) in the ascending aorta and, in the myocardium. CNR was calculated by $CNR = 2*(S_{blood} - S_{muscle})/(\sigma_{blood} + \sigma_{muscle})$.

Results

Depending on the scan efficiency (35-70%) the coronary MRA took between 6 and 10 minutes. Table 1 shows the final results for RCA and LM/LAD. Figure 1 shows two examples for T2 prepared TFE sequences.

	Volunteers	Visibile coronary segments				CNR	Vessel length /mm
		main	proximal	middle	Distal		
RCA TFE	10	N/A	10	10	8	16.1 ± 2.7	94 ± 19
RCA b-TFE	10	N/A	10	10	5	9.5 ± 1.4	64 ± 12
LM,LAD TFE	7	7	7	6	3	16.9 ± 2.5	86 ± 10

Table 1 Overview of results at coronary MRA with T2 prepared TFE and b-TFE sequences


A


B

Figure 1
Examples of coronary MRA with T2 prep TFE; (A) the LM, LAD and (B) the RCA with parts of LCx

Discussion

This preliminary study shows significant (Student t-test $p<0.05$) differences in CNR (RCA) for TFE and b-TFE sequences. Also the visualized vessel is significantly longer ($p<0.05$) for the TFE sequence. Values for CNR with TFE are in good agreement with Stuber et al. [1]. Problems with b-TFE sequences for coronary MRA at 3T are probably caused by imperfect shimming and B1 inhomogeneities resulting in intensity modula-tions and blurring.

Conclusion

These preliminary results indicate the feasibility of coronary MRA at 3 Tesla. Good results were achieved with non-balanced-TFE sequences. The balanced-TFE sequence will benefit from minimizing off-resonance effects by improvements in shimming and new start-up sequences.

References

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