DIAGNOSTIC VALUE OF CONTRAST-ENHANCED WHOLE-HEART CORONARY MRA AT 3.0TESLA

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Introduction: With the increased availability of clinical 3T MR scanners, high expectations are set for coronary MR imaging in terms of scan time, resolution and image quality. The feasibility of performing contrast-enhanced whole-heart coronary MRA at 3T has been demonstrated recently[1]. No clinical results using this technique at 3T were available so far. The purpose of this study was to evaluate the clinical robustness and diagnostic accuracy of whole heart coronary MRA at 3T in comparison to x-ray coronary angiography in patients with suspected coronary artery disease.

Methods: Twenty-six consecutive patients (10 male, 62±11.2 years, average body weight 65.1Kg) with suspected coronary artery disease underwent cardiac MR examination at 3T (MAGNETOM Tim Trio, Siemens, Germany) after informed consent was obtained. All patients received x-ray angiography (CAG) within 1 week after coronary MRA. Among the 26 patients, 11 underwent 64-slice MDCT coronary angiography (Sensation 64 Cardiac, Siemens, Germany). The heart rate was controlled to be less than 75 bpm with beta blocker both for the CMRA and CTA. MR protocol: coronary arteries were imaged using an ECG-triggered, navigator-gated, inversion-recovery, segmented gradient-echo sequence with isotropic whole-heart coverage. A twelve-element matrix coil (six anterior and six posterior) was used for data acquisition. To speed up data acquisition, parallel acquisition (GRAPPA) was used in the phase-encoding direction with an acceleration factor of two. Imaging parameters included: voxel size 0.65x0.65x0.65 mm^3 (interpolated from 1.3x1.3x1.3 mm^3), TR/TE = 3.3/1.5 msec, flip angle = 20°, bandwidth = 700 Hz/pixel, imaging time = 8.9±1.9 min. Contrast agent (0.2 mmol/kg body weight, Multihance, Bracco Imaging SpA, Italy) was intravenously administered at the rate of 0.3 ml/sec. For image evaluation the coronary arteries were grouped into 9 segments: proximal、middle and distal RCA, left main coronary artery (LM), proximal, middle and distal LAD, proximal and distal LCX. For each segment, MRA image quality was graded using a four-point scale: Grade 1 indicated poor depiction of the coronary vessel with severe vessel blur; Grade 2 indicated poor contrast between the vessel and surrounding tissues with moderate vessel blur; Grade 3 indicated good vessel depiction with good vessel sharpness; Grade 4 indicated excellent vessel depiction and sharpness. Images graded 1 were excluded from stenosis assessment. The CMRA、CTA and CAG data were blinded and reviewed on a segment basis by two experienced radiologists. The accuracy of 3T coronary MRA in detecting coronary stenosis on segment basis was evaluated using X-ray angiography as the reference.

Results: MR vs CAG: Out of the total 234 segments, 31 had significant stenosis (>50%) based on CAG images. The MR examinations were successfully completed in 25 patients. 38 segments could not be analyzed by coronary MRA, 28 segments with significant stenosis were correctly diagnosed by MR. The average image quality score together with the results from segment based analysis were summarized in Table 1. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of coronary MRA on a segment basis were 90.3%, 97.0%, 84.8%, 98.2%, and 95.9%, respectively. Figure 1 shows reformatted coronary MRA images and reference X-ray angiography from a 75-year-old patient. The stenosis in LCX and RCA are well depicted (arrows). MR vs CT: From the 11 patients that underwent both MRA and CTA 12 calcified atherosclerotic plaques were detected by CT . Figure 2 illustrates left coronary artery images acquired from a patient with diffused calcified plaque using CTA, CAG and MR. In 4 out of those patients CTA did not allow diagnostic assessment due to severe calcification whereas MRA was able to visualize the vessel lumen in 4 out of the 12 with good image quality (grade >2).

Conclusions: 3T whole-heart contrast-enhanced coronary MRA showed good diagnostic accuracy for detection of significant stenosis. The results of the study in sensitivity, specificity, PPV and NPV fall into the lower range of reported values from recent CT literature[2]. These results justify optimism that further improvements in spatial resolution and imaging speed may lead to clinically acceptable coronary MRA examinations[3].

Reference:1. Bi X, Carr J, Li D. MRM 2007; 58:1-7. 2. Achenbach S. JACC 2006; 48: 1919 – 1928. 3. Stuber M, Weiss RG. JMRI 2007; 26:219-234.

Table 1. Results of Stenosis Assessment by 3T CE MRA Compared with CAG (n=234)

Segment	TP	TN	FP	FN	Non-assessable Segments	Average MR image quality
LM	1	22	0	0	3	3
LAD(proximal)	6	16	2	0	2	2.8
LAD(middle)	4	20	0	0	2	2.7
LAD(distal)	0	15	0	0	11	1.7
LCX(proximal)	2	21	0	1	2	2.7
LCX(distal)	4	11	0	0	11	2.0
RCA(proximal)	2	22	1	0	1	3.0
RCA(middle)	7	17	0	0	2	2.9
RCA(distal)	2	16	2	2	4	2.5
Total	28	160	5	3	38	2.6

TP=ture positive TN=ture negative FP=false positive FN=false negative

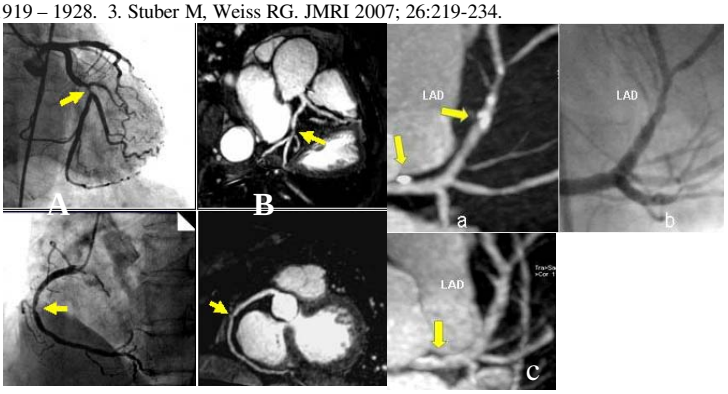

Fig. 1 A 75-year-old patient. Significant stenosis at proximal LCX and middle RCA (arrow) . Consistent finding with CAG (A) and coronary MRA (B). **Fig. 2** A 70-year-old patient. Representative CTA (a), CAG (b) and MRA (c) of the left coronary artery from a patient with diffused calcified plaque..