3T Contrast-Enhanced Whole Heart Coronary MRA using 32-Channel Cardiac Coils for the Detection of Coronary Artery Disease

Q. Yang[1], K. Li[1], X. Bi[2], J. An[3], F. Huang[4], R. Jerecic[2], and D. Li[5]

[1]Radiology, Xuanwu Hospital, Beijing, China, People's Republic of, [2]Siemens Medical Solutions, [3]Siemens Mindit Magnetic Resonance Ltd, [4]Invivo Corporation, [5]Northwestern University

Introduction: The development of contrast enhanced whole heart coronary MR angiography (CMRA) at 3T has shown promising results in clinical studies for the detection of significant coronary artery stenoses. However, the imaging time (~ 9 minutes) and spatial resolution (1.3 × 1.3 × 1.3 mm^3) remain major limitations[1,2]. Newly available 32-channel cardiac coils allow greater acceleration factors, and thus reduced imaging time, reduced contrast agent dose and higher spatial resolution[3].

Purpose: To evaluate the diagnostic accuracy of 3T contrast enhanced whole-heart CMRA with an optimized protocol for improved spatial resolution and reduced scan time using a 32-channel cardiac coils. Imaging time, image quality score, and diagnostic accuracy are evaluated in 32 consecutive patients with suspected coronary artery disease using conventional x-ray coronary angiography (CAG) as reference standard.

Methods and Materials: 32 patients with suspected coronary artery disease who were scheduled for coronary angiography (CAG) (mean age 62 ± 12 y) underwent MRCA at 3T (MAGNETOM Tim Trio, Siemens) after informed consent was obtained. A 32-channel receiver coil was used for data acquisition (Invivo, Gainesville, FL). For image acquisition an ECG-triggered, navigator-gated, inversion-recovery prepared, segmented gradient-echo sequence was used with an acceleration factor of three in the phase-encoding direction using GRAPPA reconstruction. Imaging parameters included: voxel size 0.55x0.55x0.65 mm^3 (interpolated from 1.1x1.1x1.3 mm^3), TR/TE = 3.3/1.5 msec, flip angle = 20°, bandwidth = 700 Hz/pixel, TI=200 msec. Contrast agent (0.15 mmol/kg body weight, MultiHance, Bracco, Italy) was intravenously administered at a rate of 0.3 ml/sec. For image analysis, standard 15-segment AHA classification system was used and only segments with a reference diameter of ≥ 1.5 mm were included, excluding those segments distal to complete occlusions. The diagnostic accuracy in detecting significant stenoses (≥50% of vessel lumen) was evaluated on the assessable segments only, as well as on all segments. Both non-assessable segments and the segments of the patients where the scan failed were considered to have a stenosis.

Fig 1: 3T whole-heart coronary MR images of a 50 year-old patient acquired with 32-channel cardiac coils. Reformatted images (a,b) demonstrate normal LM, LAD, and RCA. Long segments of all major coronary arteries can be clearly visualized by volume rendering after removing the background (c), which correlate well with x-ray angiography (d,e).

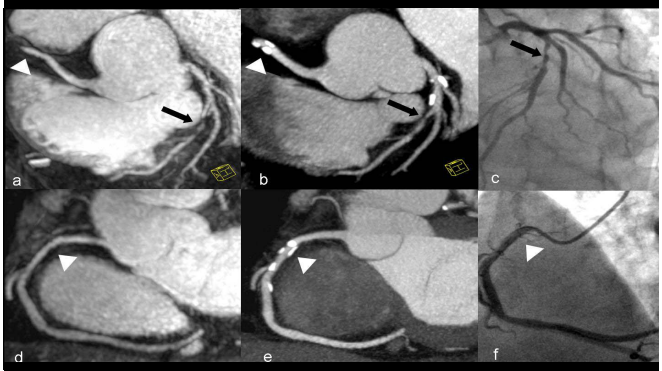

Fig. 2: 3T whole-heart coronary MR images of a 72 year-old patient acquired with 32-channel cardiac coils (imaging time: 3 min 34 sec). Reformatted image (a) detects a significant LAD stenosis (arrow) with good correlation with CTA (b) and CAG (c). Reformatted image (d) shows normal lumen (arrow head) of the RCA at the site of the calcifications which were overestimated by CTA (e) and is confirmed by CAG (f).

Results: Whole-heart CMRA was successfully completed in 30 of 32 (94%) patients who were scheduled for CAG. The averaged imaging time was 5.9 ± 1.2 min. 40 of 392 segments (10%) with a reference luminal diameter > 1.5 mm on QCA were determined as non-assessable. On assessable segments only, the sensitivity, specificity, and accuracy of coronary MRA for detecting significant stenoses were 93% (78-99%), 99% (97-99%), 98% (96-99%), respectively. On all segments, the sensitivity, specificity, accuracy were 93% (78-99%), 82% (78-86%), 83% (79-87%), respectively. Direct comparison of 32 channel and 12 channel CMRA was summarized in table 1. Example images are shown in Fig 1 and 2.

Table.1 3T CMRA using 32channel coils VS 12 channel coils

	32-ch coils	12-ch coils
Study success rate	94%	90%
Imaging time	5.9 ± 1.2 min	9.0 ±1.9 min
Non-assessable Segments	40/392(10%)	93/781(12%)
Sensitivity (%)	93% (78-99)	88(81-95)
Specificity (%)	99% (97-99)	97 (96-99)
Accuracy (%)	98% (96-99)	96 (94-98)

Conclusion: Combined with dedicated 32-channel cardiac coils, parallel imaging with higher acceleration factors allows significant reduction in imaging speed and reduced dose of the contrast agent when compared to our previous results[1]. This is mainly due to the overall reduced scan time, allowing the acquisition of a larger portion of k-space data in the plateau phase of the signal during slow infusion and is less prone to patient movement during prolonged scan times. These improvements resulted in substantially improved overall accuracy of coronary MRA in detecting coronary artery disease.

Reference:1. Yang Q, Li D, et al. *Proceedings of 16th annual ISMRM*, Toronto. 2008 **2.** Pouleur AC, Gerber BL. *Circ Cardiovasc Imaging* 2008;1;114-121 **3**.Niendorf T, et al. *Magn Reson Med.* 2006;56:167-176.