Coronary Artery Imaging at 3T: A 32- versus 6-channel cardiac coil comparison

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Introduction: Though coronary artery MR-imaging has been investigated for the past decade, long scan times have played a part in its slow translation to routine clinical practice. The recent advent of array coil technology with high numbers of elements allows for higher SENSE factors, which lower the scanning time to a more acceptable level [1-2]. The trade-off of higher acceleration is lower signal-to-noise (SNR), which can be mediated by going to a higher field strength [3]. Previous studies have investigated the use of a 32-channel coil at 1.5T [1-2], however, only recently has this technology become available at 3T. In the present study we investigated whether the reduced scan time achieved with a new 32-channel cardiac coil provided sufficient coronary artery image quality. A comparison to the current 6-channel coil using two different acquisition strategies at 3T was performed.

Table 1.		32-channel		6-channel	
		Targeted	Whole-heart	Targeted	Whole-heart
Vessel length	RCA	90 ± 27	96 ±28	95 ± 29	98 ± 30
	LM + LAD	62 ± 12*	52 ± 12	56 ± 7	52 ± 15
Vessel diameter	RCA	3.0 ± 0.3	3.5 ± 0.3	3.0 ± 0.2	3.6 ± 0.4
	LM + LAD	2.7 ± 0.2	3.2 ± 0.5	2.7 ± 0.2	3.2 ± 0.4
Vessel sharpness	RCA	0.43 ± 0.04	0.55 ± 0.05	0.42 ± 0.04	0.51 ± 0.05
	LM + LAD	0.37 ± 0.04	0.52 ± 0.07	0.37 ± 0.06	0.48 ± 0.06
SNR muscle	RCA	16 ± 8	12 ± 5	17 ± 6	16 ± 6
	LM + LAD	14 ± 4	14 ± 5	14 ± 5	14 ± 6
SNR blood	RCA	32 ± 15	23 ± 11	33 ± 10	29 ± 8
	LM + LAD	31 ± 11	27 ± 10	31 ± 11	26 ± 11
CNR	RCA	16 ± 8	11 ± 7	16 ± 4	12 ± 3
	LM + LAD	17 ± 7	12 ± 4	17 ± 6	12 ± 5
Image quality	RCA	3.0 ± 0.0	2.6 ± 0.5	2.9 ± 0.8	2.9 ± 0.6
	LM + LAD	2.6 ± 0.7	2.8 ± 0.7	2.8 ± 0.7	2.6 ± 0.7

Materials and Methods: Nine healthy volunteers (30 ± 7 years old, 6 male, 3 female) were scanned in the supine position on a 3T MRI scanner equipped with a 6-channel and a 32-channel cardiac coil (Philips Healthcare, Best, Netherlands). After localization scans, 3D fast segmented gradient echo sequences (two, targeted, small slabs covering the right and left systems and a whole-heart) were performed. Imaging parameters for the targeted sequences included TR/TE=5.5/1.59 ms, flip angle=20^o, and a resolution of 1x1x3mm^3. For the whole-heart scan, which was acquired in the transverse plane, the resolution was 1.5x1.5x1.5 mm^3 isotropic with a TR/TE=4.1/1.16ms and flip angle=20^o.The acquisitions were ECG-triggered and navigator gating was used to correct for respiratory motion. The acceleration factor was increased with the 32-channel coil from 2 to 2.4 for the targeted scans and from 2 to 4 for the whole-heart sequence. Objective values of SNR, CNR, and vessel sharpness for the right and left coronary artery systems were determined for all scans using the 'soap bubble' analysis tool [4]. A subjective quality score of 1-4 (1-poor, 2-moderate, 3-good, 4-excellent) was assessed by a blinded, independent, expert reviewer. Statistical differences were evaluated by a Student's t-test analysis.

Results and Discussion: The average nominal scan time (without navigation) for the whole heart sequence was ~4 minutes and ~2 minutes for the 6- and 32-channel coils, respectively, while for the targeted scans the time was reduced from ~1:45 min to ~1:15 min for each segment. The objective and subjective image qualities of the 32-channel coil were overall similar to the 6-channel coil with only one value (LM+LAD targeted vessel length) achieving statistical significance with p=0.04 (Table 1). There was very little difference in vessel sharpness, CNR and image quality when comparing the whole-heart images from the 32- and 6-channel coils despite almost halving the scan time. The same general trend was seen with the targeted scans. Due to the different resolutions between whole-heart and targeted, it was difficult to compare vessel sharpness within these groups. The images for the RCA of one volunteer reformatted from the whole-heart scan are shown in Figure 1, while an example of the targeted left coronary is shown in Figure 2. The image quality of these cases was similar for each coil.

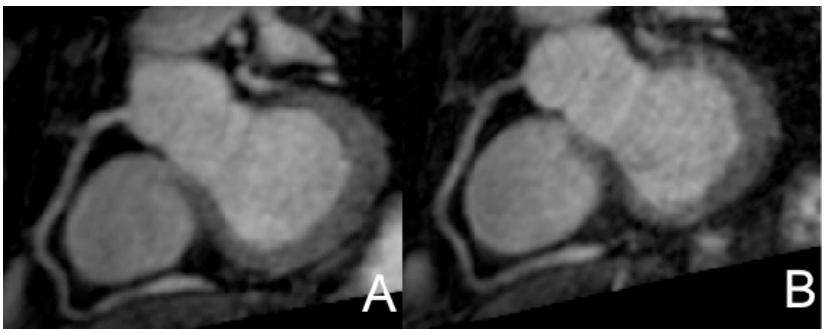

Figure 1. RCA from the whole-heart scan with the 6-channel (A) and 32-channel (B) coils

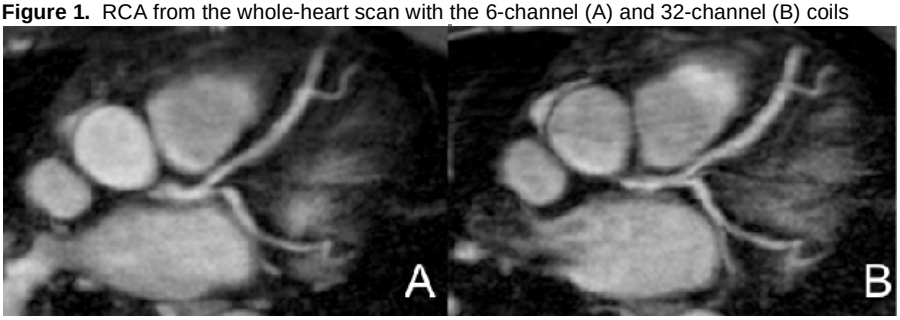

Figure 2. Targeted left coronary scan with the 6-channel (A) and 32-channel (B) coils

Conclusion: 32-channel coil technology can reduce the scanning time for coronary artery imaging while maintaining image quality. It is especially beneficial for a whole heart approach where SENSE in two directions can be exploited. When diagnostic quality of the coronaries is required, it is still preferential to use a targeted sequence, however, if this information is additional to the rest of the exam, the whole-heart sequence can provide sufficient image quality in a short amount of time and does not require extra planning. Overall, the combination of a 32-channel cardiac coil and 3T allows the possibility of high quality coronary artery imaging in less than five minutes which makes it more attractive for widespread clinical use.

References: [1] Nehrke K, JMRI 2006;23:752-756. [2] Niendorf T, 2006;56:167-76. [3] Huber ME, MRM 2004;52:221-227. [4] Etienne A, MRM 2002;48:658-66.