

Free-breathing versus breath-hold 32-channel coronary vessel wall imaging at 3T

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Background: As coronary x-ray angiography often underestimates the true burden of atherosclerotic disease, direct imaging of coronary vessel wall thickness may provide a better measure of the "true" extent of coronary artery disease. As a result, several approaches for the non-invasive assessment of coronary vessel wall thickness and plaque volume have been investigated over the past several years. [1-4] Cartesian, radial and spiral magnetic resonance imaging (MRI) sequences have been employed with success in both navigated and breath-hold versions. Most studies have been carried out at 1.5T with one study at 3T [5]. In the present study we sought to invest the combined gain in signal-to-noise (SNR) at 3T, with spiral k-space sampling and the use of a 32-channel receiver coils to perform single breath-hold coronary vessel wall imaging.

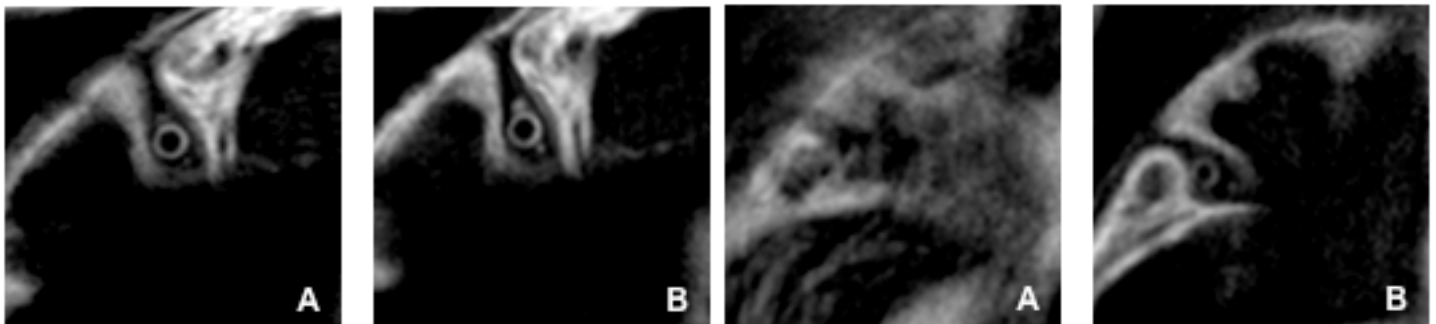
Aim: The purpose of this study was to investigate the image quality and robustness of a 2D dual-inversion black-blood spiral coronary vessel wall imaging sequence at 3T with a 32-channel coil and compare breath-hold versus free-breathing navigated versions of the sequence.

Materials and Methods: Ten healthy volunteers (29 ± 6 years old, 7 male, 3 female) were scanned in the supine position on a commercial 3T MRI scanner with a 32-channel phased array cardiac coil (Philips Healthcare, Best, The Netherlands). After localization of the right coronary artery (RCA), a perpendicular slice was selected in the proximal portion of the RCA. The 2D VECG triggered spiral dual-inversion (DIR) vessel wall sequence with a resolution of 0.6x0.6x8mm was performed during free breathing with a respiratory navigator and as a breath-hold for comparison. Imaging parameters included FOV=220mm, TR=26 ms, TE=2.1 ms, flip angle=45°, 1 spiral interleave per cardiac cycle, acquisition window=20 ms, and slice-selective re-inversion slice thickness of 10 mm. The duration of the breath-hold was approximately 20-30 seconds, depending on the heart rate. Only the anterior 16 elements of the coil were used to minimize foldover associated with small field-of-view imaging. The lumen diameter and vessel wall thickness were measured by prescribing an inner and outer circle according to [1] in Osirix. The SNR of the vessel wall and the contrast-to-noise ratio (CNR) with respect to the dark lumen blood-pool were calculated to provide objective measures. A subjective quality score of 1-4 (1-not visible, 2-fair, 3-good, 4-excellent) and an artifact score of 1-3 (1-severe, 2-moderate, 3-no artifacts) were assessed by a blinded, independent, expert reviewer.

Table 1. Comparison of Breath-hold versus Navigator-gated Black-Blood Coronary Vessel Wall MRI

	Lumen diameter (mm)	Vessel wall thickness (mm)	SNR	CNR	Image quality	Artifact score
Breath-hold	3.1 ± 0.5	0.70 ± 0.11	15 ± 1	4.4 ± 2.3	2.7 ± 1.0	2.5 ± 0.8
Navigated	3.4 ± 0.2	0.69 ± 0.11	16 ± 7	6.4 ± 5.3	2.5 ± 1.0	2.2 ± 0.4

Results and Discussion: Six of the 10 volunteers had sufficient image quality in the breath-hold or navigated scan (or both). The remaining four volunteers had no visible vessel in either sequence and were excluded from further analysis. The lumen diameter and vessel wall thickness were similar in both the breath-hold and navigated sequences as was the CNR and SNR (Table 1). In five of the six volunteers, the breath-hold image had sufficient image quality. An example of this is shown in Figure 1. In one volunteer who had difficulty with the long breath-hold, the navigated scan was superior (Figure 2).



Figures 1 and 2. Breath-hold (A) and navigated (B) images from two different volunteers.

Conclusion: Breath-hold black-blood coronary vessel wall imaging with a high spatial resolution is enabled by the combination of 3T, spiral imaging and 32-channel coil architecture. While the robustness of the 2D spiral DIR vessel wall sequence at 3T needs further investigation, this preliminary study shows promising results and suggests that the breath-hold approach provides a valuable alternative for those subjects capable of holding their breath for a relatively long period while the navigated version is optimal for those who cannot. The overall technique provides an option for clinical use due the similar results of breath-hold and navigated techniques.

References: [1] Botnar RM, *Circulation* 2000;102:2582-2587. [2] Fayad FA, *Circulation*;102:506-510. [3] Botnar RM, *Magn Reson Med* 2001;46:848-854. [4] Desai MY, *Eur Heart J* 2005;26:2320-2324. [5] Botnar RM, *JCMR* 2003;4:589-94.