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High resolution, free-breathing coronary artery imaging with >99% respiratory efficiency

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Introduction

High-resolution coronary artery acquisitions are generally gated to end-expiration using navigators and have intrinsically low respiratory efficiency (RE), which is exacerbated by respiratory drift. Alternatively, epicardial fat can be used as a marker of coronary artery position in a 3D beat-to-beat non-model based subject-specific respiratory motion correction (B2B-RMC) technique[1]. We propose this technique can acquire high-resolution coronary artery images with approximately 100% RE.

Methods

In-plane right coronary images were acquired in 10 subjects on a Siemens 1.5 T Avanto scanner. For B2B-RMC, a 3D low resolution spiral dataset with fat selective excitation was acquired every cardiac cycle immediately before 2 interleaves of a 3D high-resolution spiral dataset with water selective excitation. A following navigator was used to reject data at extreme respiratory positions (>10 mm outside normal range). Beat-to-beat respiratory displacement of the coronary artery was determined from the low resolution images using localized 3D normalized subpixel cross-correlation of fat around the coronary origin (relative to end-expiration) and used to retrospectively correct the corresponding high-resolution interleaves. Navigator gated (5 mm window) 3D balanced steady-state free-precession (nav-bSSFP) with T2-prep and identical resolution to the B2B-RMC technique was chosen for comparison.

Analysis

For each B2B-RMC and nav-bSSFP dataset, a maximum intensity projection was generated with anatomy overlying the artery nulled. Average vessel diameter (full-width half maximum) and sharpness (inverse of 20-80% intensity distance[2]) were measured in the proximal (0-20 mm) and mid (20-40 mm) arteries.

Results

The RE was 99.7% (range 98.4-100%) and 40.7%, (range 33.2-53.6%) for B2B-RMC and nav-bSSFP respectively (paired t-test $p < 0.0001$). There was no significant difference in proximal or mid sharpness between the two methods (table 1), no significant difference between methods for mid diameters and a significant but insubstantial (0.15 mm) difference in proximal diameter which is possibly due to reduced vessel wall signal in the T2-prepared nav-bSSFP technique. Figure 1 shows B2B-RMC images optimally corrected for the proximal(a) and distal(b) vessel (RE = 99.3%) and the equivalent nav-bSSFP results(c) (RE = 41.0%).

Conclusion

High-resolution coronary artery images were acquired with 99.7% RE using B2B-RMC in 10 subjects. Diameter and sharpness in the proximal and mid vessel were not substantially different to values obtained with nav-bSSFP acquired with mean RE 40.7%. For optimal visualisation, the B2B-RMC method requires cross-correlation of a *local* region of fat, as demonstrated in (a) and (b). Further work

Table 1: Average right coronary artery sharpness and diameter obtained using two imaging techiques

	Proximal sharpness (mm^{-1})	Mid sharpness (mm^{-1})	Proximal diameter (mm)	Mid diameter (mm)
B2B-RMC (standard deviation)	1.00 (0.14)	1.01 (0.11)	2.85 (0.38)	2.85 (0.39)
nav-bSSFP (standard deviation)	1.08 (0.11)	1.05 (0.12)	2.70 (0.34)	2.80 (0.35)
Paired t-test p-value	0.15	0.24	0.026	0.60

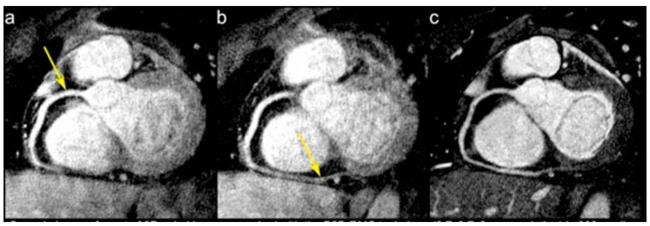

Figure 1
Curved planar reformat of 3D spiral images acquired with the B2B-RMC technique (0.7 × 0.7 × 3 mm resolution) in 302 cardiac cycles (93.3% efficient) over 20 mm of diaphragm motion, corrected for optimal proximal (a) and distal (b) vessel quality. For comparison the equivalent curved planar reformat of the 3D nav-bSSFP with identical resolution acquired in 612 cardiac cycles (41.0% efficient) is shown (c).

will merge images corrected for both proximal and distal vessel motion to generate a single corrected dataset.

References

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