Comparison of Cartesian and Radial SSFP Coronary MRA

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Introduction

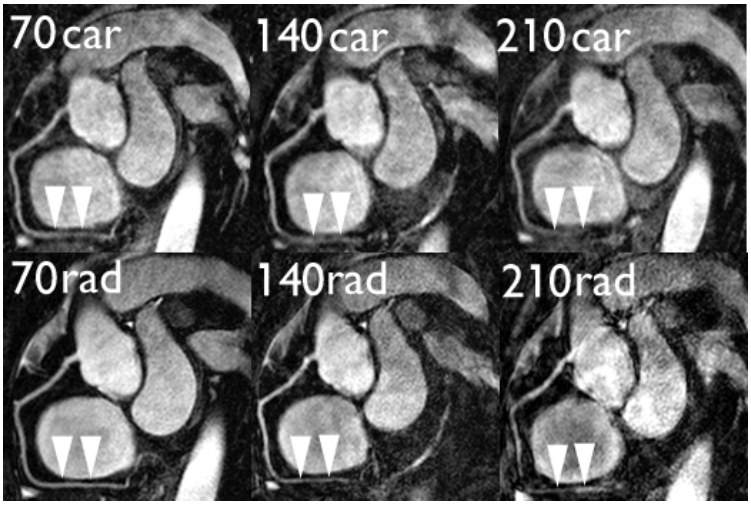
Coronary magnetic resonance angiography (MRA) is a promising non-invasive alternative to X-ray coronary angiography (1). Despite advances, the main obstacles for reliable depiction of the coronary artery lumen are cardiac and respiratory motion. Free breathing coronary MRA in combination with navigator echoes, a subject specific trigger delay, and, mid- to end-diastolic acquisition window (typically less than 100 ms) has helped minimizing motion related artifacts. However, even with these advances, ~20% of coronary MRA studies are non-diagnostic, probably due to artifacts related to residual coronary motion. Recently, attention has been directed towards steady-state free precession (SSFP) balanced TFE (bTFE) coronary MRA using Cartesian (2,3) and radial (4,5) k-space sampling. In this study we sought to investigate the impact of the k-space trajectory and acquisition window duration on image quality. We hypothesize that non-Cartesian (radial) k-space filling may be less sensitive to bulk cardiac motion and thus advantageous for coronary MRA.

Purpose

To compare Cartesian- and radial-bTFE coronary MRA and to investigate the influence of acquisition duration on image quality.

Materials and Methods

Free breathing, navigator gated and corrected radial and Cartesian 3D bTFE coronary MRA with subject specific mid-diastolic trigger delay and different acquisition window durations (70, 140, and 210 ms) was performed in 10 healthy adult subjects (mean age: 30). To minimize motion related artifacts due to RR-variability, an arrhythmia rejection algorithm was used (6). All imaging was done on a 1.5T clinical MR scanner (Gyroscan-NT, R9.1, Philips Medical Systems, Best, The Netherlands) using a vector ECG and a 5-element cardiac receiver coil. Five left and 5 right coronary arteries were imaged. Imaging parameters for the Cartesian 3D bTFE were: TR = 5.4 ms, TE = 2.7 ms, flip angle = 110º, scan duration = 2min56s @ 70 bpm. Imaging parameters for the radial 3D bTFE sequence were; TR = 6.2ms / TE = 3.1ms, flip angle = 120º, scan duration = 4min @ 70 bpm. In-plane spatial resolution of both sequences was 1.0x1.0 mm and 10 slices of 3mm thickness were acquired (zero interpolated to 20 slices of 1.5 mm). Scan durations decreased by a factor of 2 or 3 when the longer acquisition windows were used. All 6 sequences were acquired in random order. To assess the influence of the different k-space filling algorithms and acquisition windows on image quality we used the following end-points: mean vessel length for left main and anterior descending (LAD), circumflex (LCX) and right coronary (RCA) arteries; vessel sharpness, and mean vessel diameter for the first 20 mm of the left (left main and anterior descending combined) and right coronary arteries.



Results

Radial 3D balanced FFE with the shortest acquisition window duration (70 ms) allowed for longest mean coronary artery visualization (table). For both Cartesian and radial imaging, mean coronary artery length decreased with increasing acquisition window duration (range: -2 to -35%). Vessel sharpness was significantly higher for all acquisition window durations when radial imaging readout was used (all $P < 0.05$). An example is shown in the **figure** (top: Cartesian acquisitions at 70, 140 and 210 ms acquisition duration, respectively; bottom: radial acquisitions at 70, 140 and 210 ms acquisition duration, respectively). Note better delineation of the distal part of the coronary arteries for the radial acquisitions (arrowheads). There were no significant differences in vessel diameter between the two different readout techniques nor for the different acquisition windows (no more than 8% variation for all arteries between techniques and different acquisition windows).

	Cartesian 70	Radial 70	Cartesian 140	Radial 140	Cartesian 210	Radial 210
LAD length	61±5	64±5	59±4	63±3	54±9	56±6
LCX length	39±8	42±5	35±5	40±3	32±5	31±10
RCA length	115±19	134±17	111±12	122±14	104±17	89±36
LAD sharpness	0.46±0.06	0.62±0.05	0.48±0.05	0.62±0.05	0.50±0.04	0.58±0.04
LCX sharpness	0.41±0.06	0.58±0.07	0.42±0.09	0.55±0.06	0.43±0.05	0.58±0.09
RCA sharpness	0.45±0.05	0.60±0.07	0.48±0.06	0.60±0.07	0.46±0.07	0.59±0.03

Discussion and Conclusions

Radial bTFE allows for better coronary artery delineation when compared with Cartesian bTFE, (higher vessel sharpness). These results encourage further studies in selected patients groups to determine the diagnostic accuracy of both techniques.

References

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