MR Coronary Vessel Wall Imaging using Radial and Spiral k-Space Sampling

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Introduction

Several studies have demonstrated the use of black-blood MRI for non-invasive visualization of the coronary vessel wall [1,2]. For routine clinical use, however, image quality and robustness remains to be improved. Recently, a local re-inversion method in combination with spiral data acquisition was introduced that allowed for 3D imaging of the coronary vessel wall [3]. Using a similar approach, a gradient-echo (GRE) sequence with Cartesian and radial k-space sampling as well as a steady-state free-precession (SSFP) sequence with radial data acquisition were compared revealing that the GRE imaging with radial k-space sampling provides consistent good image quality with reduced motion artifacts [4]. We therefore sought to compare radial and spiral k-space sampling with respect to motion artifacts in particular. Furthermore, we implemented a slice-selective instead of a 2D-selective re-inversion pulse for ease of planning and to take advantage of the improved inversion profile. Maximum flow exchange was achieved by performing the double inversion pre-pulse immediately before the early systolic right coronary blood flow (RCA) flow peak [5]. This resulted in a slightly prolonged inversion time (TI) when compared to the optimal delay for blood signal suppression.

Materials and Methods

RCA vessel walls of eight healthy subjects (6 men, 2 women; mean age: 37 ± 11 years) were imaged on a 1.5 Tesla MR system (Gyroscan ACS-NT, Philips Medical Systems, Best, NL) using a double-inversion prepared black-blood GRE (radial: TR/TE 8.0/2.0 ms, FA 30°, 13 profiles/cardiac cycle; spiral: TR/TE 30.0/2.0 ms, FA 45°/90°, spiral interleaves 42, 2 profiles/cardiac cycle) with identical spatial resolution (0.8 x 0.8 x 2.0 mm^3). For data analysis, two investigators blinded to sequence parameters subjectively assessed image quality in terms of artifacts and vessel wall visualization. In addition, SNR, CNR, vessel wall definition and visible vessel wall length were assessed.

Results

Radial k-space sampling demonstrated fewer artifacts (radial: 1.2 ± 0.5; spiral: 2.5 ± 0.7, $p < 0.05$) and led to improved visualization of the coronary vessel wall (radial: 1.4 ± 0.8; spiral: 2.0 ± 0.8, n.s.) compared to spiral imaging. This finding was also reflected in a better vessel wall definition using radial data acquisition (radial: 62 ± 8%; spiral: 56 ± 7%, $p < 0.05$). A tendency towards higher SNR (radial: 9 ± 5; spiral: 13 ± 6, n.s.) and CNR (radial: 7 ± 4; spiral: 9 ± 5, n.s.) were found when spiral k-space sampling was used. The visible vessel wall length was similar for both sequences (radial: 53 ± 17 mm; spiral: 47 ± 12 mm, n.s.).

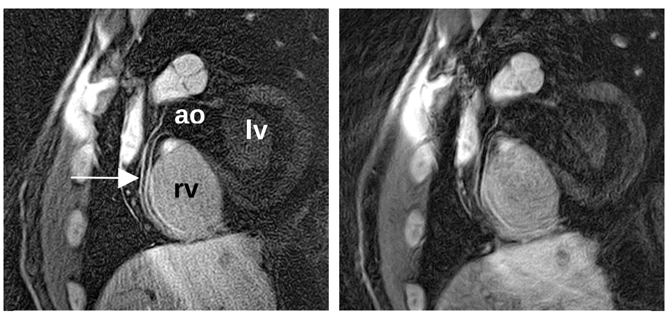

Fig. 1
MRI of the RCA vessel wall (arrow) using radial (left) and spiral (right) k-space sampling. Note the different artifact pattern in both sequences.
ao: Aorta, lf: left ventricle, rv: right ventricle.

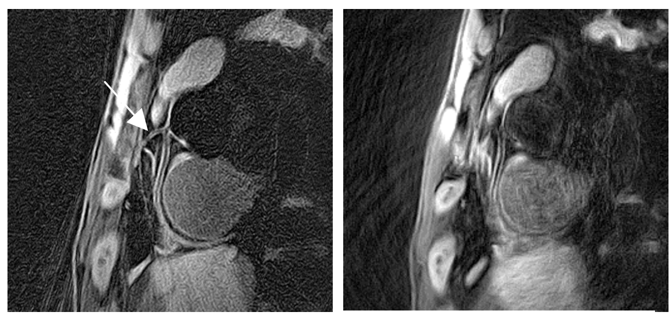

Fig. 2
MRI of the RCA vessel wall using radial (left) and spiral (right) k-space sampling. Using radial k-space sampling the vessel wall of the conus brunch is also delineated (arrow).

Conclusion

Radial k-space sampling in concert with free-breathing navigator-gated cardiac-triggered MRI of the coronary vessel wall resulted in fewer motion artifacts and improved vessel wall definition compared to spiral k-space sampling.

References

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