Steady-State Free Precession Spin Labeling Coronary Magnetic Resonance Angiography: Impact of Radial k-space Sampling

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Abstract

The aim of this study was the investigation of the impact of radial k-space sampling for steady-state free precession (SSFP) spin labeling coronary MR-angiography. In 12 healthy adult volunteers identical coronary SSFP spin labeling imaging sequences were performed using standard cartesian as well as radial k-space sampling. Contrast-to-noise ratio, vessel sharpness and motion artifact level were compared. Radial scanning showed significantly higher CNR and vessel sharpness as well as a lower motion artifact level. In conclusion, radial SSFP imaging is a new promising technique for spin labeling coronary MR-angiography.

Introduction

Free-breathing spin labeling coronary MR-angiography (MRA) has been recently implemented using navigator gated T2-prepared spiral gradient echo imaging and a 2D selective aortic spin tagging pulse (1). Using this technique, two data sets (one with and one without spin tagging) are subtracted. In the resultant image, the coronary lumen is selectively visualized. However, motion artifact suppression is crucial to avoid any subtraction errors. Hence, the purpose of this study was the investigation of radial k-space sampling for spin labeling coronary MRA, because radial scanning is less sensitive to motion artifacts. For high signal-to-noise ratio imaging in spin labeling MRA a steady-state free precession (SSFP) imaging sequence was employed (2).

Materials and Methods

Spin labeling coronary MRA of the RCA (n=5), LAD (n=4) and LCX (n=3) was performed in 12 healthy adult subjects without history of cardiovascular disease. All studies were carried out on a 1.5T Gyroscan Intera whole body MR system (Philips Medical Systems, Best, NL, 23mT/m, 219µs rise time). A five element cardiac Synergy coil was used for signal reception.

The imaging sequence consisted of a T2-prepared and fat suppressed SSFP imaging sequence (TR=6.1ms, TE=3.0ms, excitation angle=120°, field-of-view=360mm) (3). A series of 5 dummy excitations with an alpha/2 approach preceding the imaging portion of the sequence was used to obtain rapidly steady-state conditions. Identical sequences were performed with radial k-space sampling (384 radial trajectories) and cartesian k-space sampling (384 lines). Twelve 3mm slices were reconstructed to 24 1.5mm slices and an in-plane resolution of $0.7 \times 0.7 mm^2$ using a 512 reconstruction matrix. 16 RF-excitations per R-R interval resulted in a data acquisition window of 96ms.

For spin labeling (spin inversion), a 2D selective aortic spin tagging pulse (1) was applied directly after closure of the aortic valve (flip-angle 180°, 35mm diameter). During the labeling delay between the inversion pulse and end-diastolic imaging the labeled blood washed in to the imaging slab. After subtraction of two data sets (one with and one without spin tagging), only the labeled blood is seen (1). Hence, coronary artery lumen can be selectively visualized.

For data analyzing contrast-to-noise ratio (CNR), vessel sharpness and subjective motion artifact level (3 point grading scale, 1=best, two investigators blinded to sequence parameters) were compared using bi-directional Students t-test.

Results

Selective aortic spin tagging in conjunction with SSFP coronary MRA allowed for selective and high contrast visualization of the coronary lumen while surrounding tissue was almost completely suppressed (Figure 1). Radial scanning yielded superior CNR (34.4+/-10.8 vs. 17+/-4.9, $p<0.05$) and vessel sharpness (81+/-21 vs. 66+/-26, $p<0.05$). Superior subjective motion artifact suppression was seen on radial images.

Conclusion

Spin labeling coronary MRA with radial SSFP imaging is a new promising approach with an improved image quality when compared to cartesian k-space sampling.

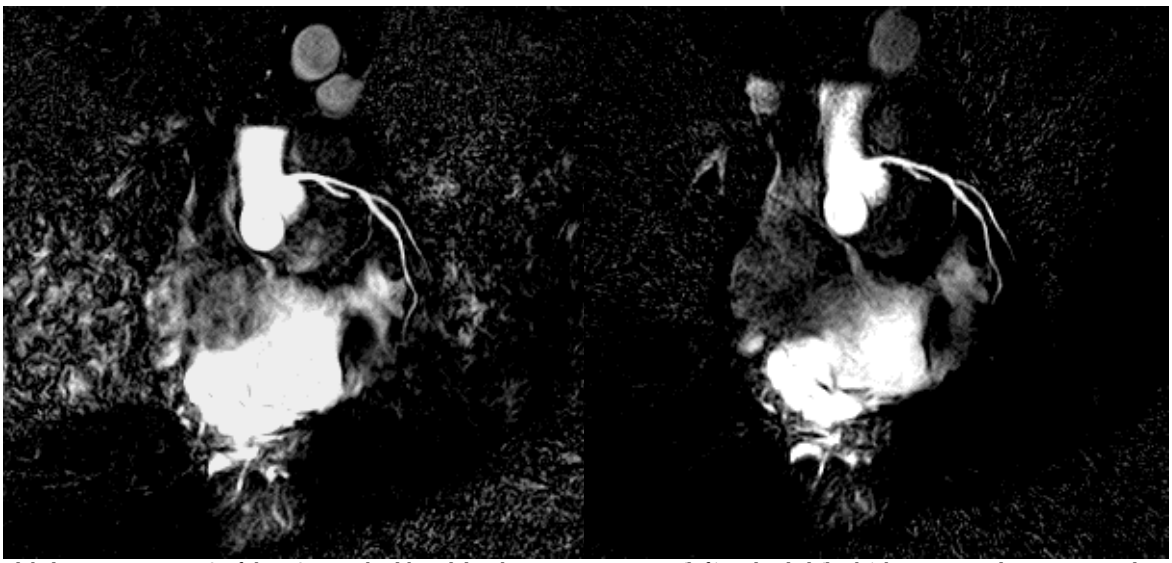

Figure 1: Spin labeling coroanry MRA of the LAD in a healthy adult subject using cartesian (left) and radial (lright) k-sapce sampling. Image quality is improved using radial scanning.

References:

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