Flow-Sensitive Inversion-Prepared SSFP Coronary MR Angiography

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Introduction

Recently, a new inversion-prepared steady-state free-precession (SSFP) MR angiography (MRA) technique was introduced for the visualization of the blood flow within the right coronary artery (RCA) (1). Hereby, a slab-selective inversion pre-pulse, which was positioned along the main axis of the coronary artery but perpendicular to the imaging volume, was applied prior to imaging in order to suppress signal from the coronary blood and tissues that are included in the inversion volume. During an inversion delay unsaturated blood from the ascending aorta enters the coronary artery. This inversion concept allowed for direct and directional visualization of inflowing coronary blood.

In this study, the reliability of the novel inversion-prepared SSFP MRA technique was evaluated in volunteers and patients for the right and left coronary system.

Materials and Methods

Inversion-prepared coronary MRA was performed in 14 volunteers (6 female, 8 male; 33 $\pm$ 11 years) and 17 patients (6 female, 11 male; 60 $\pm$ 9 years) on a 1.5 T whole-body MR-system (Intera, R 9.1.1, Philips Medical Systems, Best, NL) using a free-breathing navigator-gated and cardiac-triggered 3D SSFP sequence (TR/TE 6.3/3.2 ms, FA 120°, FOV 360 mm^2, matrix 384 radial trajectories, 0.9 x 0.9 x 3 mm^3). Radial k-space sampling was employed for improved motion artifact suppression. Imaging of the RCA was performed usign a slab-selective inversion pre-pulse as described previously (1), while a 2D selective (pencile-beam) inversion pre-puls was used to image the left anterior descending (LAD) coronary artery in order to maintain full magnetization of the blood in the left ventricle.

Coronary MR angiograms obtained in patients were assessed in terms stenotic lesions ($\geq$ 50%) and subjective image qulity (1: good, 2: moderate, 3: poor) by two radiologists. Diagnostic accuracy was evaluated by comparison to convetional x-ray angiography, which served as the reference standard.

Results

In all volunteers and patients inversion-prepared SSFP MRA was successfully completed for the right and left coronary system. Representative coronary angiograms in volunteers are shown in Fig. 1 (RCA) and 2 (LAD).

In the patient study, coronary angiograms with good and moderate image quality were achieved in 15 and 2 cases, respectively (poor image quality = 0). All together, 40 coronary segments were evaluated for stenotic lesions. Hereby, all stenoses were accurately identified (true positive = 7; true negative = 32). In Fig. 3, a moderate stenosis at the proximal LAD is shown, which was confirmed by conventional angiography (Fig. 4). In one case, an irregular vessel contour due to an artifact was misinterpreted as a stenotic lesion (false positiv = 1; false negative =0).

Conclusion

Inversion-prepared SSFP coronary MRA yielded constantly good image quality for visualizing the right and left coronary system and allowed for accurate assessment of stenotic lesion at the proximal and middle portion of the coronary arteries. In addition, this approach may prove useful to differentiate between antegrade flow and collateral filling in arteries with severe stenoses.

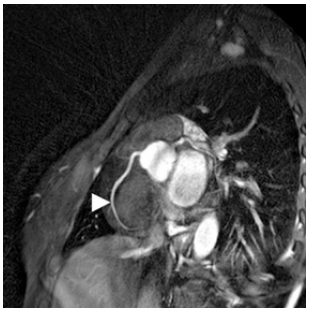

Fig. 1: RCA (arrowhead) of a healthy volunteer. Note the signal suppression of the blood in the right ventricle.

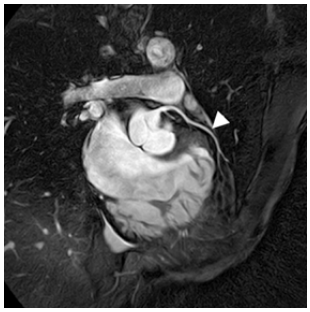

Fig. 2: LAD (arrowhead) of a healthy volunteer.

Fig. 3: Proximal LAD stenosis (arrow) of a 56 year-old male patient.

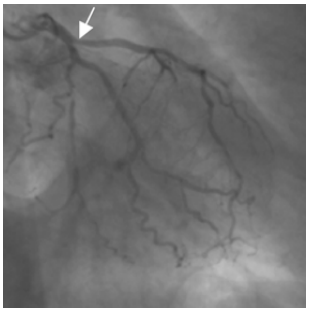

Fig. 4: The proximal LAD stenosis seen in Fig. 3 was confirmed by conventional angiography.

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