Comparison of Inversion Recovery Steady-State Free Precession and Fast Low Angle Shot Sequences for 3D Magnetic Resonance Coronary Angiography

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Introduction:

For the diagnosis of coronary artery disease (CAD), invasive coronary artery angiography must still be considered the standard of reference. However, within the last 5 years, hardware and software developments have made magnetic resonance coronary angiography (MRCA) feasible, but the diagnostic accuracy of current approaches remains insufficient for broad clinical use. Recent developments have launched different intravascular contrast agents, which have been shown to improve the image quality and the diagnostic accuracy of MRCA. However, the search for the perfect imaging sequence for contrast enhanced MRCA is not yet over. The purpose of our study was to compare inversion-recovery steady state free precession (3D-IR-SSFP) and inversion recovery fast low angle shot (3D-IR-FLASH) sequences for contrast enhanced MRCA using an intravascular contrast agent.

Materials and Methods:

28 healthy volunteers (17 male, 11 female, mean age 28±5 years) and 6 CAD patients (6 male, mean age 61±9 years) were included in this study. All examinations were performed on a 1.5T MR scanner (Siemens Magnetom Sonata) in accordance with the regulations of the local ethics committee. In all subjects, a dose of 0.15 mmol/kg body weight SH L 643A (Gadomer, Schering AG, Berlin, Germany) was injected. Thereafter, MRCA of all three major coronary arteries was performed using an IR-SSFP (TR 3.8ms, TE 1.6ms, FA 65°, 540 Hz/pixel bandwidth, voxel size 1.8-2.3mm³) sequence and an IR-FLASH sequence (TR 3.8ms, TE 1.6ms, FA 25°, 490 Hz/pixel bandwidth, voxel size 1.8-2.3mm³) in random order. For all sequences the inversion time was adapted to minimize the signal intensity of the myocardium, and the acquisition time was adjusted to the subjects' breath-hold capabilities. Signal-to-noise-ratio (SNR) and contrast-to-noise-ratio (CNR) values were calculated based on signal intensity (SI) measurements in regions-of-interest (ROI) within the vessels, the myocardium, and an artefact-free area outside the subjects. Image quality for the proximal and middle coronary segments was assessed based on a 5-point scale ranging from 1=excellent, 2=good, 3=equivocal, 4=poor, 5=non-diagnostic.

Results:

Mean acquisition time was comparable for both sequences (39.5±8.2s for FLASH versus 38.8±4.7s for SSFP). The mean image quality score for SSFP MRCA was higher compared to FLASH sequences (2.6±1.1 versus 3.3±1.0); Fig 1. The signal intensity measurements showed higher SNR and CNR values for SSFP imaging (SNR blood pool: 6.6±1.7 versus 6.1±1.5; CNR 5.2±1.7 versus 4.9±1.4); Fig 2.

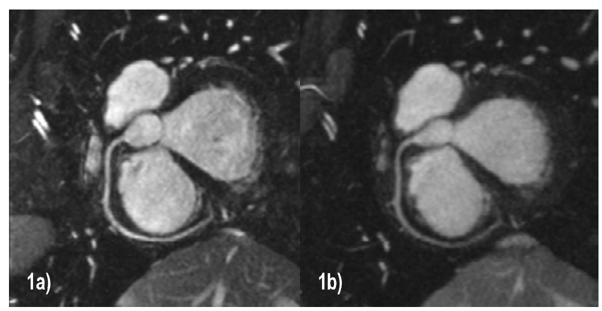

Fig 1: RCA: Insignificant better image quality for SSFP imaging (a) compared to FLASH (b).

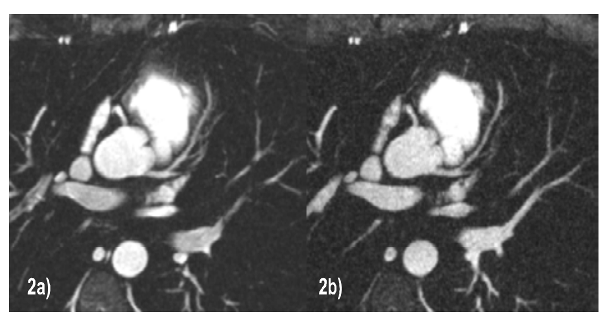

Fig 2: LAD: Higher SNR and CNR for SSFP sequence (a) than FLASH (b).

Discussion:

Although hardware and software developments have improved image quality of MRCA within the last three years, limited signal to noise and contrast to noise ratios are still an issue. Several studies have shown that intravascular contrast agents can help to overcome these limitations. However, different sequences are currently available for contrast enhanced MRCA which have not been compared so far. Following injection of extracellular contrast agents, SNR and CNR rapidly decrease due to the short plasma half-life time. Therefore intravascular compounds with constant T1 times of blood and myocardium over several minutes are preferable for the comparison of different breath-hold sequences for contrast-enhanced MRCA. Our results show an overall improved image quality for IR-SSFP sequences, and, therefore, we recommend this technique for contrast enhanced MRCA.