MR coronary angiography using a parallel acquisition technique and an intravascular contrast agent

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INTRODUCTION:

Coronary artery disease (CAD) is the leading cause of death in the developed nations. For diagnosis of CAD, invasive coronary artery angiography must still be considered as the standard of reference. Recently, magnetic resonance angiography of the coronary arteries (MRCA) has become possible due to further developments of ultrafast imaging sequences. Furthermore, blood pool MR contrast agents have been introduced, which have improved the performance of MRCA [1]. The purpose of our study was to investigate the use of a parallel acquisition technique (PAT) to increase the overall coverage during breathheld, contrast enhanced MRCA using a 3D-gradient echo sequence.

METHODS:

12 healthy volunteers (6 male, 6 female, mean age 30±5 years, range 22 - 40) were included in this study. All examinations were performed on a 1.5 T MR scanner (Magnetom Sonata, Siemens) with anterior and posterior 6-channel coil arrays. Using an inversion recovery (IR) prepared fast low angle shot (FLASH) sequence with TR/TE 241/1.6 ms, a bandwidth of 490 Hz/pixel, and an inversion time optimized for suppression of myocardial signal (TI ≈ 150 ms), images of the coronary arteries were collected with and without PAT. The use of GRAPPA [2] with a PAT-factor of 2 and 37 reference lines allowed an increase in the coverage, i.e. more slices per slab in the same acquisition time. The SNR loss due to PAT was substantially compensated by the higher signal of the thicker 3D slab. ECG triggering was used to compensate for cardiac motion. To suppress the effects of respiration, all data were acquired in a single breathhold. In all volunteers the right coronary artery (RCA), the left anterior descending artery (LAD) and the left circumflex coronary artery (CIRC) were imaged after i.v. administration of a Gadolinium-based intravascular contrast agent (SH L 643A, Schering) with a dose of 0.150 mmol/kg body weight. For quantitative comparison, 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), with noise based on the standard deviation of a ROI placed in the presumably homogeneous blood pool (bias in the PAT images due to non-uniform noise). Image quality was assessed based on a 5-point Likert scale ranging from 1=excellent, 2=good, 3=equivocal, 4=poor to 5=non-diagnostic. A student t test was performed to determine the statistical significance of observed differences. A p value < 0.05 was considered to indicate statistical significance.

RESULTS:

The mean image quality score for all volunteers was higher for FLASH imaging without PAT (2.8±0.9) compared to MRCA with parallel imaging (3.5±1.1); Fig 1. Signal intensity measurements showed higher SNR for FLASH imaging without PAT (blood pool: 13.4±3.4 versus 11.5±2.9 and myocardium: 3.0±0.5 versus 2.5±0.4), while the CNR calculation showed no significant differences (10.5±3.1 versus 9.0±2.8); Fig2.

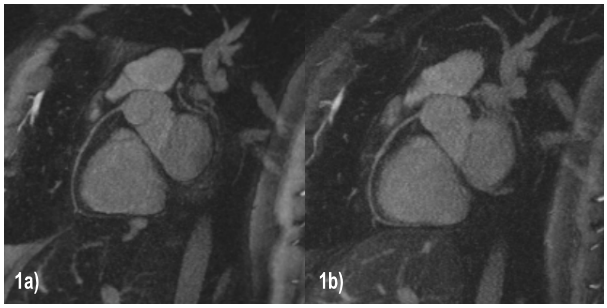

Fig 1: 3D FLASH MRCA of the RCA. Image quality is improved without PAT (a) compared to imaging with PAT (b).

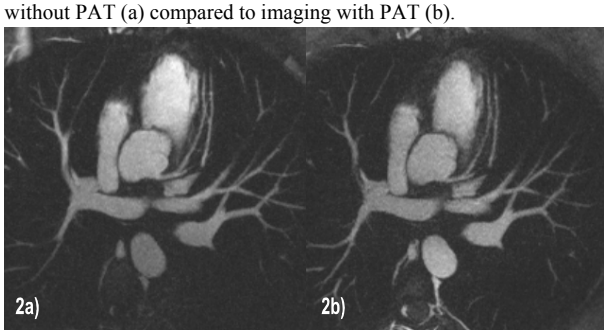

Fig 2: LAD imaging. SNR is improved using 3D FLASH sequence without PAT (a). CNR is equivalent with PAT (b).

DISCUSSION:

A remaining challenge to performing breathheld, gradient echo 3D-MRCA is the limited coverage achievable in a single breathold. Although the PAT technique showed lower SNR and subjective image quality compared to conventional 3D-FLASH imaging, the use of PAT allowed acquisition of a thicker 3D slab and enhanced coverage of the individual coronary branches. Due to the thicker slab size, the SNR penalty was only minor. In conclusion, MRCA with PAT is useful when improved coverage is needed.

REFERENCES:

[1] Herborn CU, Barkhausen J, et al. Radiology 229:217-223.
[2] Griswold MA, Jakob PM, et al. Magn Reson Med 47:1202-1210.