Coronary Magnetic Resonance Angiography – Comparisons between Gd-DTPA and Gd-BOPTA enhanced FLASH sequence and non-contrast enhanced SSFP sequence

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Introduction: Several studies have demonstrated that intravenous administration of contrast agents improve the intravascular signal of coronary arteries [1,2]. However, this effect is described as short-lived for extracellular contrast agents and therefore these compounds are not well suited for MR coronary angiography (MRCA) requiring scan times of several minutes. Recently, developed steady state free precession sequence without the use of contrast media must be considered as a state of the art technique for MRCA using either navigator or breathhold techniques to compensate for respiratory motion[3]. The aim of this study was to compare non-contrast enhanced steady state free precession (SSFP) sequences with contrast enhanced MRCA using two different extracellular contrast agents.

Methods: MRCA (1.5 T MR scanner, Magnetom Sonata, Siemens, Erlangen, Germany) was performed using a breath-hold segmented 3D SSFP sequence (TR 3.9 ms, TE 1.7 ms, FA 65°) in 5 healthy volunteers. Contrast-enhanced MRCA was performed twice on two different occasions using either Gd-DTPA (Magnevist, Schering AG, Berlin, Germany) or Gd-BOPTA (Multihance, Bracco S.p.A., Milan, Italy) in randomised order. Three, 6, 9, 12, 15, 18, 21, 24, 27, and 30 min following injection of contrast (0.2 mmol per kilogram of body weight; injection rate: 2ml/sec; 20 ml saline-flush: 2ml/sec) MRCA was performed using a breath-hold segmented 3D inversion recovery gradient echo sequence (IR-FLASH; TR 8 ms, TE 1.7 ms, FA = 15°). To determine the optimal inversion time for the MRCA sequence, a steady state free precession sequence with incrementally increased inversion times acquired during a single breath-hold (TI-Scout; TR 2.4 ms; TE: 1.0 ms; FA: 50°; temporal resolution 15 ms) was performed prior to each MRCA scan. The inversion time was set to maximize the contrast between the coronary arteries and the myocardium. SNR and CNR were measured for both contrast agents at different time point after injection as well as for the non-contrast enhanced SSFP images.

Results: MRCA could be successfully performed in all volunteers using both sequences. Using Gd-BOPTA mean SNR and CNR values were significantly higher compared to the Gd-DTPA images (SNR: 24.4 ± 1.1 for Gd-BOPTA vs 16.6 ± 1.6 for Gd-DTPA, $p<0.05$; CNR: 18.8 ± 1.6 for Gd-BOPTA vs. 11.3 ± 1.4 for Gd-DTPA, $p<0.05$; Figure 1). Compared to the SSFP sequences SNR (28.7 ± 6.9) was not statistically different for Gd-BOPTA images ($p = 0.07$) whereas Gd-DTPA showed lower SNR values ($p < 0.05$). However, Gd-BOPTA showed an increased CNR compared to SSFP images (CNR 14.3 ± 6.4, $p<0.05$) whereas Gd-DTPA did not ($p = 0.17$).

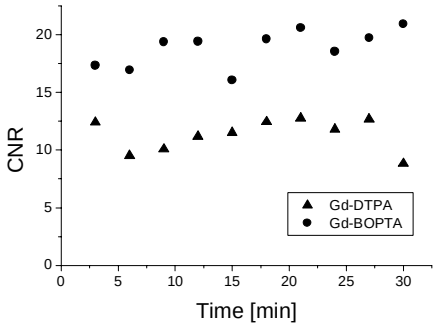

Figure 1: CNR for Gd-DTPA and Gd-BOPTA enhanced FLASH-Sequences up to 30 min after contrast injection.

Conclusion: Coronary magnetic resonance angiography is feasible using Gd-DTPA and Gd-BOPTA enhanced inversion recovery gradient echo sequences and non-contrast SSFP sequence. Due to the higher relaxivity and the mild protein binding Gd-BOPTA proved to be superior to Gd-DTPA for contrast enhanced MRCA. Compared to non-contrast enhanced SSFP sequences inversion recovery gradient echo sequences combined with double dose of Gd-BOPTA significantly improved the contrast between the coronary arteries and the myocardium.

References:

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