Myocardial Perfusion Reserve by CMR: Dual or Single Bolus Approach?

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Background: Perfusion CMR is of proven value for noninvasive diagnostics of ischemic heart disease and other cardiac pathologies. However, accurate quantification may be hampered by T1-induced clipping of the arterial input function, which is a mandatory precursor in most quantitative evaluation techniques. A dual-bolus approach has been proposed to overcome this limitation (1) and absolute values of perfusion in normals compared favourably with data from other modalities (2,3). Whether a dual bolus approach also improves accuracy in quantifying myocardial perfusion reserve in comparison to a single-bolus approach is still unknown.

Purpose: We compared regional and global myocardial perfusion reserve (MPR) and MPR indices (MPRI) using either a small pre-bolus or the main contrast agent bolus as arterial input function (AIF).

Methods: Fifteen patients (5 female, range 44-83 years) were examined within 7 days after exclusion of stenotic coronary artery disease by catherization on a 1.5T clinical MR scanner (Siemens, Sonata) in a stress-rest protocol. In two consecutive breathholds a pre-bolus (Gd-DTPA, 0.005mmol/kg b.w.) and a main-bolus (Gd-DTPA, 0.05mmol/kg b.w) were delivered during maximal vasodilation (adenosine, 140µg/kg b.w.) and during rest after 20min. Three short axis were acquired every heart cycle with a TurboFLASH perfusion sequence accelerated by parallel imaging (GRAPPA (4)) with an in-plane resolution of 1.7-2.0 x 2.6-3.0 mm.
In total 240 myocardial segments (according to the AHA 16-segment-model) were evaluated and MPR/MPRIs were derived from signal intensity-time curves based on full quantitative Fermi model constrained deconvolution (MCD), on maximum uplope (SLP) and maximum contrast enhancement (MCE). Either pre- or main bolus served as AIF. Differences between both techniques were investigated using linear regression analysis and student´s *t*-test.

Results: T1-induced saturation effects in the blood pool resulted in a main-to-prebolus ratio of 4.2 (SD=1.0) for maximum upslope and 4.6 (0.9) for maximum contrast of the AIF, which compares well with earlier findings (5). The ratios were slightly, but not significant higher under stress than under rest (6%; p>0.1). A strong positive correlation between both approaches was found for transmural MPR/MPRIs derived from all quantification methods (MDC r=0.63; SLP r=0.76, MCE r=0.81). Furthermore the slope of linear relation was close to identity (MDC a=1.07; SLP a=0.92; MCE 0.90). The differences between both approaches were small, but statistically significant on a segmental basis (p<0.001) and not significant on a per-patient (global) basis (p>0.1) (Figure 1). However, on a per-patient basis the coefficient of variation of segmental MPRs derived from the full quantitative model was considerably reduced using the dual-bolus approach (19% vs. 26%, p<0.01).

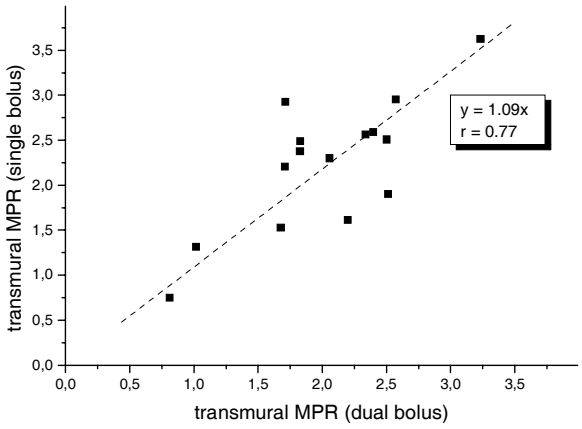

Figure 1.: Correlation of transmural global (per-patient) MPR between dual- and single-bolus approach derived from full quantitative Fermi model constrained deconvolution.

Conclusion: Consistent MPR/MPRI values were found for dual- and single bolus approach. Differences of AIF clipping under stress and rest are comparable and do not have a major impact on MPR/MPRIs. However in a dual-bolus approach a reduced regional variance of MPR is present.

References:

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