Dynamic Coronary MRA During Localized Intra-arterial Infusion of the Intravascular Agent Gadomer

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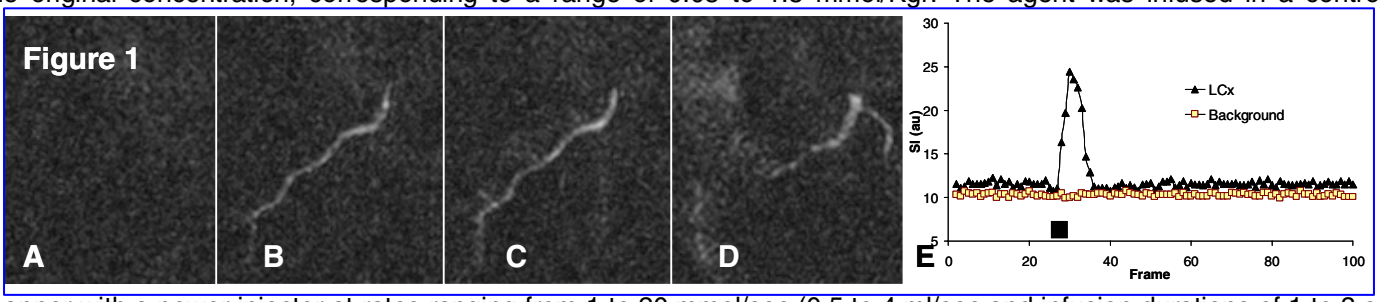
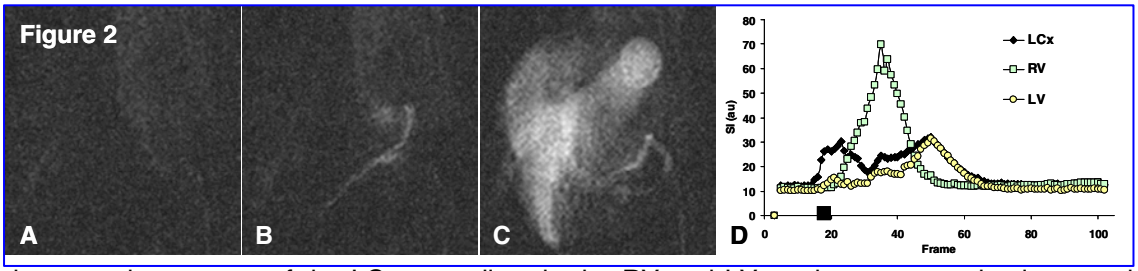
Introduction: Projection MR Angiography (MRA) of contrast enhances coronary vessels with intra-arterial (IA) localized infusion of T1-shortening Gd based agents is the approach of choice for dynamic coronary MRA in cardiac interventions [1-3]. In those studies extravascular Gd contrast agents (Gd-DTPA) were used, which offer excellent results for short duration infusions [1-3]. Since those agents freely diffuse in the interstitial space, consecutive or long infusions result to decreased contrast of the coronary artery relative to the myocardium. This is undesirable in MR-guided vascular procedures [3]. This work presents preliminary results from dynamic coronary MRA during IA infusion of Gadomer-17, an intravascular agent that generates greater and more persistent coronary contrast MRA with peripheral infusion [4].

Methods: Studies were performed on pigs (n=5) instrumented with an intracoronary (IC) catheter in the left anterior descending (LAD) or left circumflex (LCx) coronary arteries for direct IA infusion of Gadomer. The IC was placed through a carotid access under x-ray fluoroscopy before the MRI session. We tested different Gadomer dilutions of 2% to 14% of the original concentration, corresponding to a range of 0.05 to 1.5 mmol/Kgr. The agent was infused in a controlled manner with a power injector at rates ranging from 1 to 20 mmol/sec (0.5 to 4 ml/sec and infusion durations of 1 to 3 sec). Dynamic imaging during the infusion of Gadomer was performed with a non-triggered magnetization prepared [5] thick slab GRE sequence (TR/TE/α = 2.7/1.42/35^{o}; FOV = 147x147 mm; slice = 50mm; matrix = 96x96). For each infusion, we usually collected 100 frames. Region of interests (ROI) were manually traced on the contrast enhanced coronary artery to account for movement of the vessel, as well as on the left ventricle (LV), right ventricle (RV), myocardium and empty space to collect the background signal. Data were statistically analyzed and reported means and standard deviations.



Results Figure 1 shows representative frames of non-triggered coronary MRA during IA infusion into the LCx of 0.1 mmol/sec-Kgr at a rate of 2 mmol/sec (or 2ml/sec). The LCx is clearly depicted in 1B to 1D and the LAD at the later frame 1D during re-circulation. The crisp entrance and clearance of the agent and the excellent vessel-to-background contrast are evident in Graph 1E. The background (myocardium) as well as the LV and RV are not enhanced. Lack of signal enhancement was also observed in the subsequent dynamic MRA runs to study agent clearance. In all studies, no enhancement of the myocardium was observed, a clear evident that Gadomer did not diffuse to the interstitial space in quantities large enough to cause contrast compromise. Figure 2 shows a high dose (0.3 mmol/sec-Kgr) and rate (6 mmol/sec) Gadomer infusion into the LCx. Despite this infusion being the seventeenth (17th) on this animal, the background shows no enhancement (this is expected with the intravascular Gadomer). At this case the high dose is sufficient to show longer enhancement of the LCx as well as in the RV and LV as the agent re-circulates and accumulates into the blood pool. However, even at the highest doses, Gadomer clears fast the ventricular cavities (Fig. 2D) and the signal returns to the noise level, as seen after the 80th frame. Signal enhancement id never observed in the myocardium. In all studies Gadomer provided excellent vessel-to-background contrast with SNR of 21.6 ± 3.1 and contrast enhancement of 34 to 360%, depending on dilution and the rate of infusion. The studies also shown that for guiding vascular procedures the best approach is using multiple consecutive short duration (1-3 sec) and low concentration (0.015 mmol/Kgr) to avoid enhancement of the blood cavities due to the accumulation of the agent in the blood.



Conclusions These studies demonstrated that diluted Gadomer (at 2 – 14%) and slow infusion rates can be used for dynamic MRA suitable for guiding vascular interventions. Future work is focused on investigating the effect of infusion rates and efficiency of mixing of the agent and blood in localized IA delivery.

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References: [1]. Serfaty et al Radiology217, 290-5 (2000); [2]. Omary et al Circ 107, 2656-9 (2003); [3] Tsekos et al. JMRI 19, 734-49 (2004); [4] Li et al Radiology 218, 670-8 (2001), [5] Gui et al JMRI 24, 1151-8 (2006).