

Contrast-Enhanced Whole Heart Coronary MRI with Bolus Infusion of Gadobenate Dimeglumine at 1.5T

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Introduction: The potential benefits of contrast agents have been studied for coronary MRI (1); however the contrast timing/injection rate and sequence remain to be optimized. We investigated three infusion schemes (bolus, hybrid, slow) of gadobenate dimeglumine ($[Gd-BOPTA]^{2-}$, MultiHance; Bracco Imaging SpA, Milan, Italy), a high relaxivity extracellular contrast agent, for improved whole-heart coronary MRI by measuring blood T_1 kinetics. Subsequently, we evaluated a contrast-enhanced whole-heart coronary MRI method at 1.5T using an inversion-recovery SSFP sequence acquired after a bolus infusion of Gd-BOPTA.

Methods: All imaging were performed using a 1.5T scanner (Archiva, Philips Healthcare, Best, NL). Four healthy adult subjects were imaged three times each using three infusion schemes: a) bolus (0.2mmol/kg@2ml/s), b) hybrid (0.1mmol/kg@2ml/s plus 0.1mmol/kg@0.1ml/s), and c) slow (0.2mmol/kg@0.3ml/s)(1). An inversion recovery prepared T_1 -weighted segmented 2D echo-planar imaging (Look-Locker) sequence with variable inversion time (TI) for quantitative T_1 measurements. The sequence parameters were FOV=270×270 mm², TR/TE=40/4.5 ms, EPI factor = 9, flip angle = 15°, spatial resolution = 2.7×2.7 mm², slice thickness = 10 mm, and temporal resolution of 25 ms. The sequence was repeated continuously for up to 30 minutes after initiation of contrast injection. The Look-Locker sequence was started ~30 s prior to contrast injection to acquire a single data set to obtain a base-line T_1 measurement. The time-resolved signal intensity of left ventricular cavity blood was measured and the time resolved blood T_1 was calculated by fitting to an exponential T_1 relaxation curve.

Subsequently, seven healthy subjects were recruited for evaluation of a contrast-enhanced whole-heart coronary MRI. Based on the T_1 data, the bolus injection was used for the coronary MRI study. Free-breathing SSFP coronary MRI (TR/TE/ α = 3.6/1.8/90°, FOV=300×300×120mm³, resolution = 1.3×1.3×1.3mm³, T_2 -Prep, ×2 accelerated) was performed before contrast injection. Gd-BOPTA (0.2mmol/kg@2ml/s) was injected intravenously using a bolus infusion, immediately followed by a Look-Locker sequence to visually determine the optimal inversion time. A contrast-enhanced whole-heart coronary was then acquired with identical imaging parameters with the exception of replacing the T_2 -Prep with a non-selective inversion pulse. For both acquisitions, a noise scan, where the radiofrequency pulse was turned off, was performed immediately after acquisition. The blood SNR and blood-myocardium CNR were measured. The images were graded by two experienced readers on a 4-point scale (1=poor, 2=fair, 3=good, 4=very good).

Results: Figure 1 shows the blood T_1 during the first 10 min after contrast injection. The bolus injection yields the fastest and largest T_1 reduction in the initial 1-2 minutes. Slow infusion reduces the T_1 at a slower pace than bolus, but was similar to bolus ~2-3 min after injection. A hybrid infusion results in the least decrease in T_1 . Figure 2 shows a comparison of contrast-enhanced and non-contrast coronary images. The coronary SNR and CNR were significantly improved by 36% (58.5±18.7 vs. 79.5±17.5) and 101% (27.3±11.4 vs. 55.0±12.1), respectively (p<0.003 for both). The subjective score was not significantly changed with contrast when analyzed per vessel (pre vs. post: -0.25 [-0.33 – 0.17], p = 0.24) or per segment (pre vs. post: 0 [-0.5 – 0], p = 0.11). Figure 3 shows reformatted examples of the LAD, which shows improved visualization of mid and distal LAD.

Conclusions: Contrast-enhanced whole heart coronary MRI with a bolus infusion of Gd-BOPTA using inversion-recovery SSFP at 1.5T results in enhanced SNR and CNR. **Acknowledgements:** The authors acknowledge grant support from NIH R01EB008743-01A2, AHA SDG-0730339N, and Catalyst (Harvard Clinical and Translational Science Center).

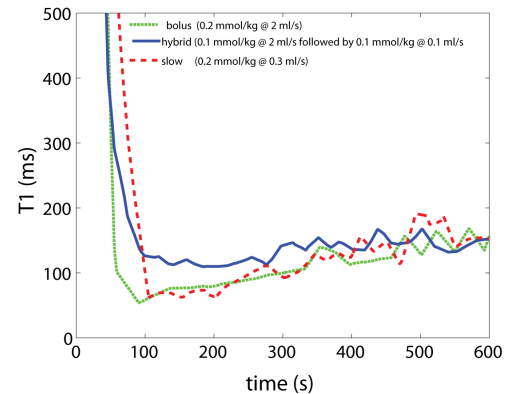


Figure 1: Time course of blood T_1 up to 10 minutes after contrast injection using three infusion schemes.

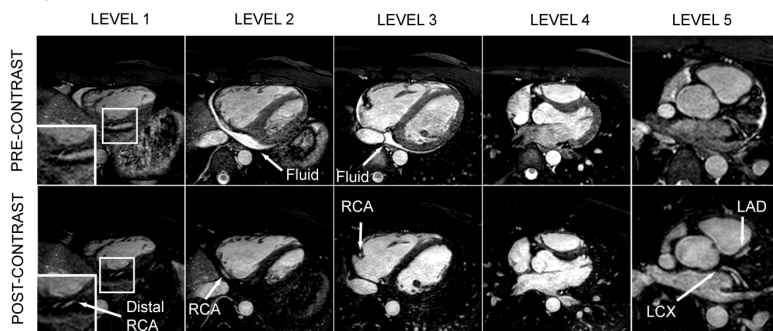


Figure 2: Example coronary images acquired on a healthy subject using an SSFP sequence before (top row) and after (bottom row) a bolus injection of Gd-BOPTA.

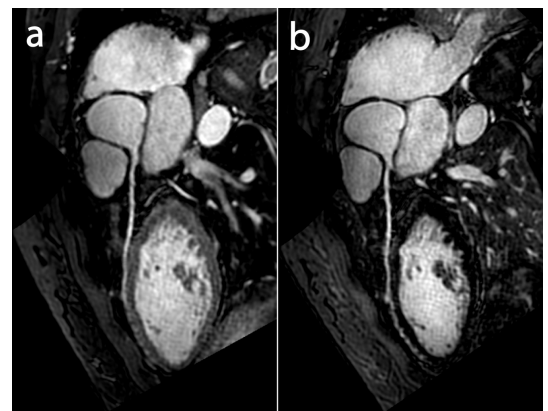


Figure 3: Reformatted non-contrast (a) and contrast-enhanced (b) LAD images. The improved suppression of myocardial signal using Gd-BOPTA facilitates depiction of mid and distal right coronary artery.

References: [1] Bi X, MRM, 2007; 58:1-7