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Moderated poster presentation

Quantitative first-pass perfusion MRI of the mouse heart

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Introduction

First-pass contrast-enhanced MRI is well established for quantifying myocardial perfusion in humans and large animals. This method would be valuable for genetically-engineered mice to study the roles of individual genes in myocardial perfusion. However, the small size and rapid heart rate of mice present technical challenges.

Purpose

To develop first-pass MRI of the mouse heart and evaluate these methods in a myocardial infarction (MI) model.

Methods

Imaging was performed on a 7 T scanner using a gradient system with a full strength of 650 mT/m and a slew rate of 6666 mT/m/ms, using a 30 mm diameter birdcage RF coil. A saturation-recovery spiral sequence was implemented, with TE = 0.36 msec, TR = 3.9 msec, interleaves = 10, FOV = 25.6 × 25.6 mm, matrix = 128 × 128, saturation delay = 40 msec, alpha = 20°, and slice thickness = 1 mm. Data acquisition was placed near the end of the cardiac cycle and its duration was 39 msec/image, approximately 1/3 of the R-R interval. Wild-type mice were imaged at baseline (n = 4) and 1 day after MI (n = 3). MI was induced by a 1 hour coronary artery occlusion. Mice were anesthetized with 1.2% isoflurane and maintained at 37°C during MRI. The dual-bolus technique was used, acquiring the arterial input and tissue functions (AIF and TF) separately. Perfusion was quantified using Fermi function deconvolution. Perfusion images were acquired for one mid-ventricular short-axis slice, and late gadolinium-enhanced (LGE) images were acquired covering the left ventricle (LV).

Results

First-pass images demonstrated uniform perfusion at baseline and reduced perfusion in the infarct zone (as defined by LGE) after MI. Example [Gd] vs. time curves for the AIF, remote zone, and infarct zone are shown in Figure 1A. Figure 1B quantifies perfusion at baseline and 1 day after MI for the infarct and remote zones. Example images are shown in Figure 1C before (i), 2 seconds after (ii), and 4 seconds after (iii) Gd injection. The perfusion defect can be observed in the anterior wall. Baseline perfusion was 4.7 ± 0.4 ml/g/min. One day after MI, infarct zone perfusion of 1.4 ± 0.4 ml/g/min was significantly lower than baseline perfusion ($p < .01$), while remote zone perfusion of 3.7 ± 1.6 ml/g/min was not significantly different than baseline.

Conclusion

To the best of our knowledge, this is the first report of first-pass cardiac MRI in mice. This technique demonstrated homogenous perfusion in normal hearts and the expected regional heterogeneity of perfusion on day 1 post-MI.

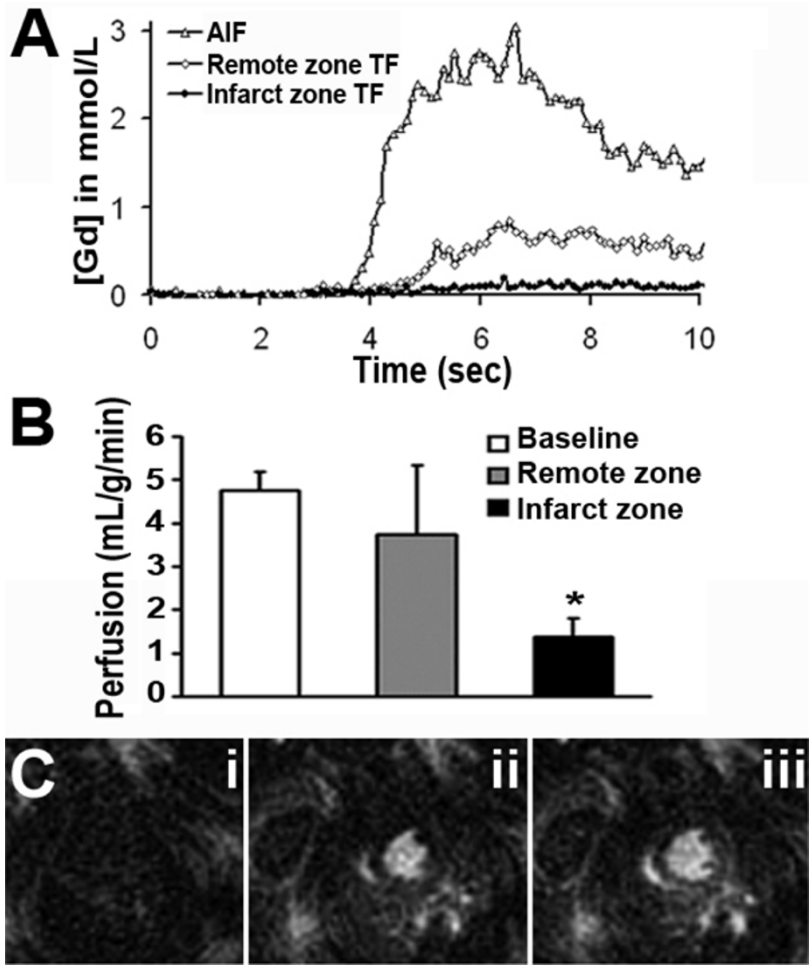

Figure 1