Title: Penetration With Time of Gd-DTPA Into Infarcted and Microvascular Obstructed Myocardium During a Constant Infusion

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Structured Abstract:

Introduction: In patients with a myocardial infarction (MI) the presence of a microvascular obstruction (MO), an area of extremely low flow, leads to worse cardiac functional outcome. When performing MRI after a myocardial infarction, gadolinium contrast agents such as Gd-DTPA are used to enhance the contrast between infarcted and healthy tissue. The MO is then operationally defined on the MR images. In positron emission tomography (PET), there is the additional problem that the resolution of PET is not enough to separate the MO and infarct regions. This causes the presence of an MO to artificially lower the intensity of PET signal in the infarct. As suggested by Prato et al, a constant infusion may be used to penetrate this MO. The purpose of this experiment is to show that it is possible to penetrate this region and to determine the rate at which contrast agents may enter it if the MR contrast agent is delivered as a slow constant infusion.

Methods: Five canine subjects were imaged with simultaneous PET/MRI (Siemens biograph mMR) five days post-MI, two of which exhibited a microvascular obstruction. MI was achieved through permanent occlusion of the left anterior descending coronary artery by snare ligation. Gd-DTPA was administered via a constant infusion of 0.004 mmol/kg/min for 150 minutes (delivering a total of 0.6 mmol/kg Gd-DTPA). T1 maps were acquired on a breath-hold in 2-chamber, 4-chamber and mid-ventricle axial views every 10 minutes. Free-breathing, T1-weighted 3D images were also acquired every 10 minutes. These 3D datasets were analysed using 3D Slicer with regions of interest drawn over the MO and infarcted regions, to quantify apparent MO and infarct volume.

Results: This research shows a decreasing trend in apparent MO volume over the course of the 150-minute constant infusion demonstrating the rate at which Gd-DTPA is entering the MO tissue. The final MO size was measured to be less than 10% of the initial measurement in one animal and less than 5% in the other. Total infarct size did not change significantly over time.

Discussion: The decrease in apparent MO size may correspond to the contrast agent being delivered very slowly through existing vasculature or by diffusion through damaged tissue. Using a constant infusion, it is possible to determine the rate of diffusion into the MO. Since the apparent MO size is changing over time the size of the MO will vary when a constant infusion is used rather than an estimate based on delayed enhancement following a bolus injection. Future work combining both a constant infusion of Gd-DTPA and FDG will be needed to determine if the penetration dynamics of FDG can be derived from the Gd-DTPA data. If that is possible then the FDG images could be corrected for partial volume and a more accurate estimate the extent of inflammation within the region of MO could be determined.