Title: Quantifying Inflammation in Infarcted Myocardial Tissue with Severely Reduced Flow: A Hybrid PET/MRI Approach Using a Prolonged Constant Infusion of 18F-FDG and Gd-DTPA

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Structured Abstract:

Introduction: After a myocardial infarction (MI), the presence of a microvascular obstruction (MO) inside an infarct increases the patient's odds of developing heart failure [Wu, Circulation, 1998]. Clinically, a bolus injection of Gd-based contrast agent in combination with magnetic resonance imaging (MRI) is used to determine the presence and size of the MO. Using the positron emission tomography (PET) tracer, 18F-fluorodeoxiglucose (FDG), inflammatory cells in the heart can be located when normal myocardial uptake is suppressed. However, if the bolus does not penetrate the MO, the presence of inflammatory cells in the MO may not be properly assessed using FDG. As such, we have been using a constant infusion (CI) to investigate inflammation in the heart as opposed to the clinical bolus injection. Using a 60-minute CI, FDG does not always enter the MO [Wilk, PSMR 2016 and SNMMI 2016]. The goal of the experiment presented here is to use a prolonged 150-minute CI to determine if and when FDG and gadopentetic acid (Gd-DTPA) enter the MO. A second goal is to determine the time when suppression by lipid infusion takes effect and how long this suppression lasts.

Methods: Two animals were imaged using simultaneous PET/MRI (Siemens Biograph mMR), at 5 days post MI. The MI was induced by permanent occlusion of the left anterior descending coronary artery. During a 150-minute CI of GD-DTPA and FDG, T1 maps in 4-chamber view and 3D T1 weighted images were acquired every 10 minutes. PET data was acquired in list mode during the infusion and reconstructed in 3-minute bins. To suppress glucose uptake in healthy tissue, heparin was injected 40 minutes into the CI and a 50-minute lipid infusion was started at the same time [Lee, J Am Coll Cardiol, 2012].

Results: One animal did not have a visible infarct on gadolinium enhanced MRI. The other animal had a clear infarct and MO at 60 minutes after the CI. This MO disappeared after 150 minutes while the infarct size remained the same. Suppression took effect approximately 30 minutes after the start of the lipid infusion, where FDG uptake in the normal tissue stalled while it continued to increase in the infarct and MO. FDG concentration in the infarct and MO continued to increase until the end of the scan, 60 minutes after the end of the lipid infusion, while in the normal tissue it stayed constant.

Discussion: Since the MO disappeared after a prolonged CI, the problem of artificially lower FDG uptake in the infarcted region may be eliminated. Suppression of glucose uptake in the remote myocardium took effect within 30 minutes, contrary to our previously used 20 minutes. This suppression lasted at least 60 minutes after the lipids are turned off. Overall, this proof of principle experiment shows that it is possible to penetrate the MO using a CI and that suppression may require more time to take effect. Our future goal is to optimize the tracer delivery to reduce the time it takes the tracer to enter the MO.