Delivery of Non-Ionic Dysprosium-DTPA-BMA into Scar Myocardium Under MR Fluoroscopy

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Introduction: Vistarem (a blood pool agent) discriminates acutely infarcted myocardium from scar tissue. Dotarem-enhanced, but not Vistarem, MRI confirms the presence of scar tissue, The ability of MR to define myocardial status makes it a suitable modality for the administration of drug, gene or stem cell therapies. Since positive enhancement is utilized to delineate infarcted myocardium, we propose that negative enhancement is the appropriate mechanism for monitoring these therapies.

Purpose: To demonstrate the feasibility of MR fluoroscopy in guiding the delivery of nonionic extracellular T2* MR contrast medium Dysprosium-DTPA-BMA in scar tissue.

Methods: Pigs were subjected to 2hrs coronary artery occlusion followed by reperfusion (n=4). The animals were imaged 8 weeks after infarction using 1.5T MR scanner (Philips Medical Systems, Netherlands). Scar tissue was identified by administration of 0.026mmol/kg Vistarem (a blood pool MR contrast medium) followed by 0.1mmol/kg Dotarem (An extracellular MR contrast medium) (Guerbet Group, France) in conjunction with inversion recovery gradient echo MRI.

The guiding catheter and injecting needle (MRI-modified Stiletto 2, Boston Scientific Corporation) were adapted to serve as MRI receiver coils in parallel with surface coils. An additional receiver coil was added to the Stiletto needle tip to generate a high intensity signal on a separate receiver channel. The advancement of the endovascular catheter to ascending aorta and then to the LV was monitored using bFFE. The imaging parameters for the bFFE were: TE 1.89ms, TR 3.8 ms, flip angle 60°, slice thickness 5mm, FOV 200 mm, scan matrix 144 x 144, temporal resolution 500 ms in continuous imaging. Dysprosium-DTPA-BMA (0.4-1.0ml, 0.5M) was injected into the rim of Dotarem-enhanced region. Gradient echo MRI sequences were used to visualize the myocardial deposition of Dysprosium-chelate. Blood pressure, heart rate and oxygen saturation were measured during the intervention.

RESULTS: The scar tissue was recognized as bright region on Dotarem, but not Vistarem. The scar tissue defined by Dotarem was used as a target and was evident on bFFE images as a region of modest enhancement relative to normal myocardium (top left image). LV catheterization via arterial access was feasible under 3D MR fluoroscopy. The tip of the catheter appeared bright on MRI and the catheter could be manipulated within the ventricle to select different targets (top right image). Once appropriately positioned, the injection and consequence of the deposition of Dysprosium-chelate could be monitored on MRI. Dysprosium-chelate caused signal loss of the Doraterm-enhanced region Bottom left and right images show deposition of Dysprosium-chelate in the distal and proximal parts of the scar tissue. Successful intramyocardial injection was confirmed by the persistent loss of myocardial signal. Failure of intramyocardial injection was confirmed by the brief signal loss of LV chamber blood. Catheter navigation and intramyocardial injection of Dysprosium-DTPA-BMA caused no significant changes in blood pressure, heart rate or oxygen saturation. Postmortem evaluation showed that there was no evidence of vascular, valvular or endocardial damage.

CONCLUSION: Nonionic Dysprosium-DTPA-BMA can be mixed with potential cells during delivery to ensure intramyocardial injection and to eliminate the long-term effects of intracellular iron on stem cells or myoblasts.

Acknowledgement: This study was supported by grants from NIH (RO1HL07295) and Guerbet Group, Paris, France.

Left top image shows Dotarem-enhanced region as a thin wall, while the right image shows the active catheter in the LV pointed to the site of injection. Bottom images demonstrate the dark sites of the two injections of dysprosium-chelate (distal and proximal rims of the scar tissue).