MONITORING THE RESORPTION OF MYOCARDIAL INFARCT IN THE PRESENCE AND ABSENCE OF CORONARY MICROEMBOLI USING MRI AND MICROSCOPY

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Target Audience: Investigators whose interest lies in MR imaging of cellular and vascular integrity.
Purpose: To quantify microemboli effects on the viability of previously ischemic myocardium using MRI and microscopy at postmortem.
Methods: Percutaneous coronary intervention was performed under fluoroscopy in 16 pigs. The left anterior descending coronary artery (LAD) was occluded for 45min (group I, II) by a balloon catheter and in 8 of the animals 32mm^3 microemboli was delivered in the LAD prior to reperfusion (group II). A 1.5T MR scanner was used at 3 days and 5 weeks to acquire ECG-gated delayed contrast enhanced MRI (DE-MRI) in groups I and II. For myocardial viability, inversion recovery gradient-echo sequence was used to delineate damaged myocardium. The imaging parameters were: TR/TE/flip angle=5ms/2ms/15°; FOV=26×26cm; slice thickness=6mm without gap; read and phase matrix size=256x162, NEX=2 and TI=220-240ms. DE-MRI images were acquired at 10min after delivery of 0.15mmol/kg Gd-DTPA. At the conclusion of the second imaging session, the hearts were excised, sliced and fixed by 10% formalin then stained with Masson trichrome to microscopically measure scar tissue using planemetry. Infarct size on DE-MRI and gold-standard microscopy were compared. A semi-automatic threshold technique (+3SD remote myocardium) was used for quantification of MI. Registration between 3 days and 5 weeks was achieved using anatomical landmarks and distance from the apex. Cardiac injury biomarkers and tissue samples were used to confirm/deny and validate MI.
Results: At three days, group I animals showed focal infarct on DE-MRI with the extent of 3.3±2.2g, while group II animals showed significantly larger focal and patchy infarct of 9.8±0.6g (P<0.01) (Figure). At 5 weeks, group I animals showed shrinkage infarct size (1.3±0.9g or 60%) on DE-MRI, but the shrinkage was substantially less in group II (7.7±0.5 or 22%, P<0.01), suggesting slow healing in microembolized infarct or tissue resorption is infarct size dependent. Infarct sizes were significantly greater on microscopy in group I (2.8±0.4) and II (13.4±2.4) at 5 weeks. The figure shows the microscopic changes in minor infarct (top right panel) and microembolized infarct (bottom right panel). There was no significant difference in cardiac injury biomarkers between groups I and II at 24hrs but the elevation of troponin I was greater in group II than I at 72hrs (Table 1). Microscopic examination revealed a random distribution of microemboli, vascular remodeling, and traces of inflammatory cells in the LAD territory of group II (Figure).

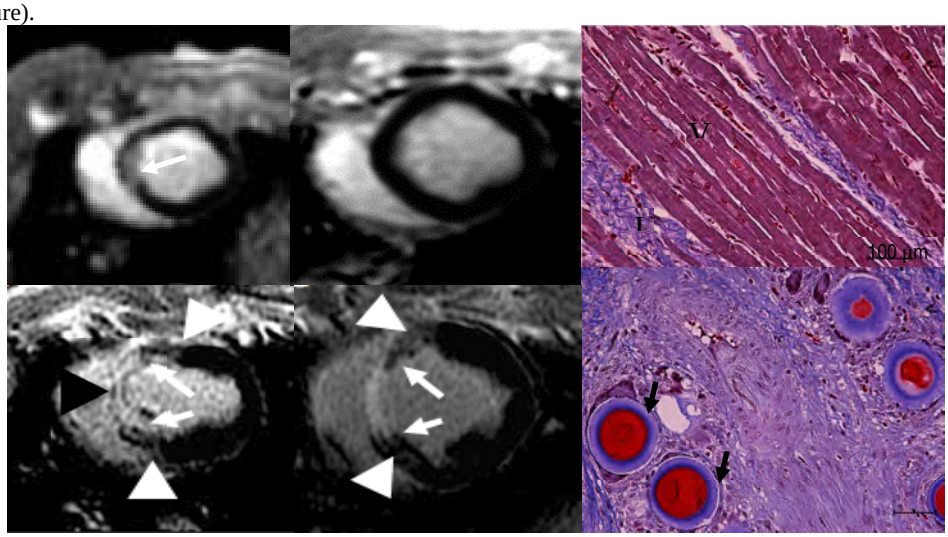

Figure. Delayed contrast enhanced imaging acquired at 3 days (left) and 5 weeks (middle) from group I (top) and II (bottom) show myocardial infarct (white arrow), microvascular obstruction (black arrowhead) and patchy microinfarct in the border zone (white arrowhead). Histological sections (right) show the difference between the two groups and microemboli (black arrows). I = Infarcted myocardium, V = Viable myocardium. Histology = 200X.

Table 1. Dynamic cardiac injury biomarkers over the course of 3 days after interventions

	Biomarkers	Pre-intervention	24hrs post intervention	72hrs post intervention
Group I (n=8)	Creatine kinase MB	567±57	3408±609*†	1218±217*†
	Troponin I	<0.04	34.3±5.6*†	1.9±0.5*†
Group II (n=8)	Creatine kinase MB	501±93	2538±710*†	1149±211*†
	Troponin I	<0.04	32.6±7.4*†	4.9±1.0*†

*P<0.017 compared with pre-intervention and †P<0.017 compared with group I.

Conclusion: Delayed contrast enhanced MRI has the potential to detect additional loss of cellular integrity in the territory exposed to microembolization. However, this technique has limited spatial resolution for measuring true microinfarct when compared to gold standard microscopy. Furthermore, cardiac injury biomarkers are also limited in their ability to differentiate the effect of intervention (microemboli) on ischemic myocardium at 24hrs. MRI may be useful in testing the efficacy of newer distal protective devices in eliminating microemboli during coronary revascularization.