MICROSCOPIC VALIDATION DELAYED CONTRAST ENHANCED 3D INVERSION RECOVERY (IR) GRADIENT ECHO MRI IN BEATING AND NON-BEATING SWINE HEARTS

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Hypothesis: Large myocardial infarction has been measured using both 3D and 2D delayed enhancement MRI and validated using macroscopic histochemical staining (1). The purpose of this MRI study was to: 1) measure diffuse and large infarction size using delayed contrast enhanced 3D inversion recovery (IR) gradient echo (GRE) in beating and non-beating swine hearts and 2) compare the 3D measurements against 2D-IR GRE, macroscopic histochemical staining and microscopic histopathology.

Methods: Pigs were subjected to: 1) diffuse infarction by infusing 32mm^3 microemboli in the LAD (group I, n= 7), 2) large infarction by occluding LAD for 90min (group II, n=7) or 3) combined large and diffuse infarction by occluding LAD for 90min and infusion of 32mm^3 microemboli (group III, n=7). Three days following coronary intervention, contrast enhanced 3D (TE/TR/TI=2.3/4.8/230-240ms) and 2D (TE/TR/TI=1.8/6.8/230-240ms) was performed for measuring myocardial infarction in beating hearts. The animals were then euthanized inside the scanner and reimaged using the same imaging sequences. At postmortem, histochemical triphenyltetrazolium chloride (TTC) and microscopic histopathology (hematoxylin-eosin) stains were used for validation. Student Paired and unpaired nonparametric t-tests and ANOVA with Dunn's multiple comparison tests were used as appropriate.

Results: There was no significant difference in infarction size between delayed contrast enhanced 3D and 2D MRI in both beating and non-beating hearts (Table 1). Furthermore, theses sequences demonstrated the gradients in infarction size as a function of insult severity. In beating hearts close correlations and agreements were found between infarction size measured on 3D and 2D MRI (r=0.81-0.95 for all groups, bias: group I 0.033±1.2 %, group II 0.13±1.2%, group III -0.17±1.8%). Acute large infarction was overestimated on 3D and 2D MRI in beating hearts compared with microscopy. Fig. 1 demonstrates a close correlation between 3D MRI in beating hearts and microscopy of combined large and diffuse infarction (group III), but 3D MRI underestimated true myocardial infarction size (bias: -2.2 ± 1.6 %) due to the inherent limited spatial resolution and the small islands of necrosis.

Conclusion: Myocardial infarction measured on 3D MRI is highly correlated and in a good agreement with infarction measured microscopically. This imaging sequence has the potential to measure diffuse and large acute myocardial infarction and has minimal motion artifacts.

Table 1. Infarct size on 3D, 2D-LGE MRI, histochemical staining and histopathological.

	3D-IR GRE	2D-IR GRE	TTC	Microscopy
Beating heart				
Group I	9.0±0.6	9.0±0.3		
Group II	14.4±0.6*$^{+}$	14.3±0.5*$^{+}$		
Group III	16.0±1.8*	15.8±1.6*		
Non-beating heart				
Group I	9.0±0.4	9.2±0.7 8.4±0.4		
Group II	14.6±0.6*	14.1±0.5*	14.9±1.8*	13.3±0.5
Group III	16.1±1.9*	16.1±2.1*	16.0±1.6*	17.8±1.8$^{\#\$}$

*P<0.05 compared with group I, $^{\#}P$<0.05 compared with coherent 3D and 2D,
$^{\$}P$<0.05 compared with group II, ^{+}P<0.05 compared with microscopy of the same cohort.

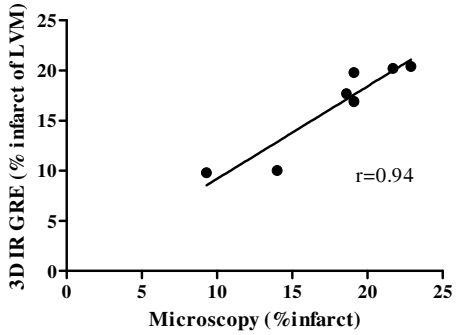

Fig. 1. Correlation between microscopy and 3D MRI in beating hearts of group III animal.

References: 1. Dewey M et al. Radiology 2006:239: 703-709.