

In vivo risk zone assessment in the rat at 1.5T using Manganese Enhanced Magnetic Resonance Imaging (MEMRI).

J-L. Daire¹, J-N. Hyacinthe¹, I. Gunes Tatar¹, K. Montet-Abou¹, M. Ivancevic¹, M. Costa-Jorge M², D. Morel², J-P. Vallée¹

¹Radiology, University Hospital of Geneva, Geneva, Switzerland, ²Anesthesiological Investigations Unit, University Hospital of Geneva, Geneva, Switzerland

Introduction

Manganese-enhanced MRI (MEMRI) has been recently used to determine the zone at risk of the heart myocardium based on imaging of manganese perfusion during occlusion (1). Due to the difficulty to perform simultaneous imaging and coronary occlusion in rat, a sequential protocol where occlusion and manganese injection are performed first followed by MRI needs to be validated. We hypothesized that manganese accumulation in mitochondria allows sufficient signal enhancement to accurately image the zone at risk after of the occlusion.

In this study, we examined the feasibility of the risk zone assessment in the rat, based on a MnCl₂ injection during a coronary artery occlusion model at 1.5T.

Methods

Fifteen adult Sprague-Dawley rats underwent a single 30 minutes episode of coronary artery occlusion followed by reperfusion. Manganese chloride (MnCl₂) was injected at the beginning of occlusion at 4.8 ml/h during 5 minutes for 11 rats (group 1) and 6 hours after reperfusion for 4 animals (group 2). All images were acquired on a clinical scanner at 1.5T (Philips Medical System, Best, NL). ECG-gated T1 inversion recovery sequences (TR/TE 13/8.9 ms, inversion time 220-300ms, FA 45°, 416x416 matrix sampled, 160x96 mm FOV, 2 mm thickness) were used to cover the whole heart in short and long axis and to determine the size of non-enhanced myocardium area. Post mortem macroscopic slices of 2 mm were analyzed for each heart with 2 dyes: methylene blue for area at risk definition and triphenyltetrazolium chloride solution (TTC) for infarct delineation.

Results:

In group 1, MR images were acquired 1h30 ± 30 min after occlusion. A clear deficit of enhancement was observed in all the rats (fig 1). Hypo-enhancement area in group 1 was correlated to the zone at risk (fig. 3) and statistically larger than the TTC infarct zone (p=0.001). In group 2 (injection 6 hours after occlusion), the hypo-enhancement area was correlated to the infarct zone and statistically smaller than the risk zone (p=0.008) (fig. 2).

Conclusion

This work demonstrates that hypo-enhanced zone obtained after manganese perfusion during occlusion represents the area at risk and not only the infarct zone. This proves the feasibility of cardiac function and viability analysis in rat at 1.5T and appears as a promising tool in small animal heart disease model.

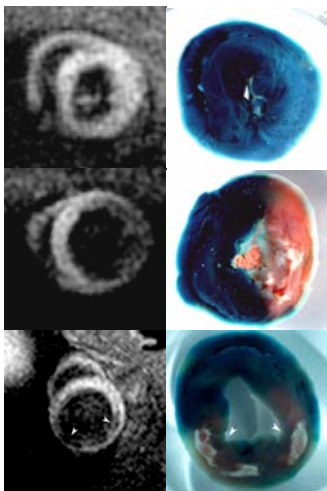


Figure 1: Example in the case of normal area (first row), injection during occlusion showing a hypointense MR signal area corresponding to the risk zone shown by the blue dye (second row). injection 6h after occlusion allows to well depict the infarct revealed by the TTC (third row)

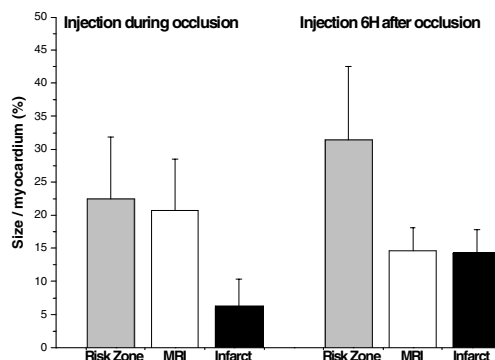


Figure 2: Surfaces measurements on MnCl₂ enhanced MR images (white column), risk zone (grey column) and TTC (infarct) area (black column).

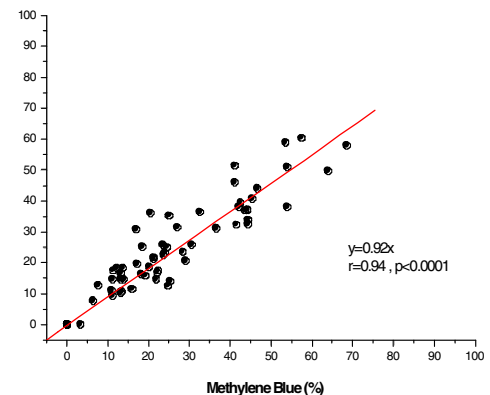


Figure 3: Correlation between the size of non-enhanced area on MR images and the surface with no methylene blue uptake

References:

1. Natanzon, A., et al., *Determining canine myocardial area at risk with manganese-enhanced MR imaging*, Radiology, 2005, 236(3) : p. 859-66.

Supported by the Swiss National Science Foundation PP00B-68778/1