

Feasibility of C-SPAMM rat heart tagging after manganese injection

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Introduction

It has been shown that Manganese Enhanced Magnetic Resonance (MEMR) can be used to depict, in a non invasive way, the myocardial area at risk in models of coronary occlusion-reperfusion [1]. To this purpose $MnCl_2$ solution is injected during the occlusion. In such models, we cannot evaluate global and regional function before $MnCl_2$ injection. Thus, we need a technique to evaluate cardiac contraction in presence of manganese.

MR tagging is an accurate tool [2] to evaluate abnormal myocardial motion. It allows regional myocardial strain quantification with transmural resolution. However, the quality of measurement can be critically affected by tag fading even with C-SPAMM technique. As manganese decreases the relaxation time T_1 of the myocardium, it may affect the tag persistency and hence the quality of resulting strain measurements.

The purpose of this study was to evaluate whether, after $MnCl_2$ injection in the rat heart, the quality of resulting strain measurements is still compatible with quantitative analysis.

Methods

Six normal Sprague-Dawley rats weighing 457g (± 27 g) were imaged on an Intera 1.5 T system (Philips Medical Systems, Best, NL) with: C-SPAMM tag preparation, 2 line directions and 1 mm tag distance, segmented cine FFE sequence, 47 mm surface micro-coil, prospective ECG trigger, free breathing, TR/TE=12/6 ms, FA=10° with a FA ramp, 128x256 matrix sampled on a cartesian grid, FOV=80 mm, 2 mm slice thickness, and 12 phases per heart beat. Total acquisition time per slice was about 1:40 minutes. MR images were acquired before and 15 minutes after an IP injection of 8 mL of $MnCl_2$ solution (corresponding to a total amount of 8 μ mol). Images were analyzed using peak-combination HARP method[3, 4]. Myocardial strain was calculated from the tracked contours in four cardiac sectors (septal, anterior, lateral, and inferior) and then averaged.

Results

We observe no significant effects of manganese on MR tagging measurements but a clear increase of liver signal. We measure an increase ($p < 0.001$) in the contrast-to-noise ratio (CNR) after injection (Fig. 1 and Fig. 2). The strain measurements were successfully performed with HARP both before and after manganese. The strain measurements over all animals show no statistical differences ($p > 0.1$ in three cases) between normal images and manganese enhanced images (Fig.3). The strain gradient from epicardium to endocardium was observed before and after $MnCl_2$ injection ($p < 0.001$ in both cases). The short repetition time (due to high heart rate) limits the impact of shorter relaxation times on tag fading (Fig. 1).

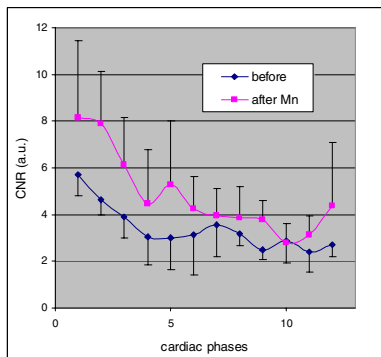


Figure 1. Increase of the contrast to noise ratio (CNR) after $MnCl_2$ injection (average over all animals, $p < 0.001$).

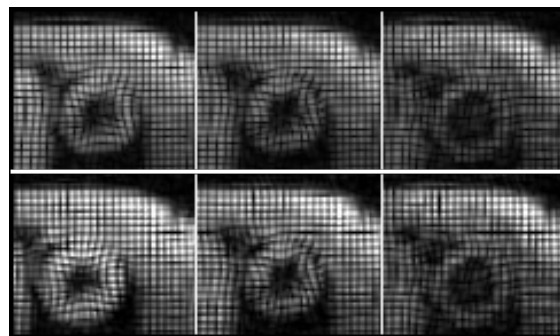


Figure 2. tag images evolution through heart phases (left to right) and after injection of $MnCl_2$ (bottom).

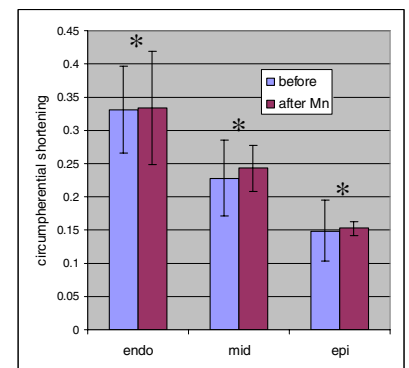


Figure 3. Myocardial strain in endocardial, midwall and epicardial regions (* : $p > 0.1$).

Conclusion

With C-SPAMM technique and a short acquisition time (given by the high rat heart rate), manganese injection does not affect the myocardial strain measurements with MR tagging. Thus, MR tagging can be used for regional function quantification in an area at risk protocol in rat after $MnCl_2$ injection.

References

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