Comparison of In Vivo and Ex Vivo R1-map-based Percent-Infarct-Mapping Using Gd(DTPA)

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INTRODUCTION

Our recently developed method for MRI quantification of myocardial viability, Percent-Infarct-Mapping (PIM) (Surányi et al, MRM, 2006), quantifies infarct content per voxel, based on the R1 value. This is made possible by the delayed accumulation of contrast agents into myocardial infarcts. The traditional analysis of delayed enhancement (DE) images results in either infarcted (bright) or viable voxels (dark) and therefore it tends to overestimate infarct size. PIM, however, allows the determination of the per-voxel percentage of infarcted tissue. The accuracy of the PIM method is shown here using in vivo and ex vivo R1-mapping using Gd(DTPA) and TTC-staining.

METHODS

In dogs (n=5), 96h following closed-chest, coronary-occlusion (180min), in vivo Gd(DTPA)-enhanced Percent Infarct Mapping was carried out during continuous Gd(DTPA) infusion (0.2mmol/kg bolus followed by 0.0033mmol/kg/min) using an inversion recovery prepared fast gradient echo sequence (slice thickness/FOV/matrix/TE/TRp/flip/VPS/TR=10mm/240mm/256x192/3.19ms/7.18ms/25º/16/3cardiac cycles) and six inversion times. Secondly, 15 minutes before sacrifice, 0.2mmol/kg Gd(DTPA) was administered. Thus, the heart was excised at the optimum time for infarct vs. viable tissue contrast. Ex vivo (Figure 1) short-axis inversion-recovery (IR) fast-spin echo images were acquired with varying inversion-time (50-1000ms) (slice thickness/FOV/ matrix/flip angle/TE/ETL/TR=3mm/160mm/256x256/90°/12.3ms/16/2000ms). R1 and Percent-infarct values were calculated voxel-by-voxel. During image analysis, the only manual input was tracing the endo- and epicardial contours in all slices. Left ventricular infarct volume (IV) and infarction-fraction (IF) were calculated from PIMs, and from TTC-staining.

RESULTS

Very close agreement was found between PIM and TTC-staining (Figure 2). Excellent ($p<0.01$ for all) pairwise correlations were obtained for IV_{PIM} vs. IV_{TTC} (R^2=0.99 and 0.98 for in vivo and ex vivo, respectively) and IF_{PIM} vs. IF_{TTC} (R^2=0.99 and 0.97 for in vivo and ex vivo, respectively). IV_{PIM} slightly overestimated IV_{TTC} by 1.79±1.43ml and -0.17±1.96ml, for In Vivo and Ex Vivo, respectively. IF_{PIM} overestimated IF_{TTC} by 3.22±1.81% and 4.28±3.77%. The mean difference between In Vivo and Ex Vivo PIM was 3.68±2.79ml and 1.97±1.99%, for IV and IF, respectively.

CONCLUSIONS

From Gd(DTPA)-enhanced R1-maps, voxel-by-voxel PIMs can be generated both In Vivo and Ex Vivo. There is no need for sharp infarct contour delineation, and patchy infarct regions are thus identified. The automated quantification of infarct size is possible using PIM and results are in good agreement with the gold standard, TTC-staining.

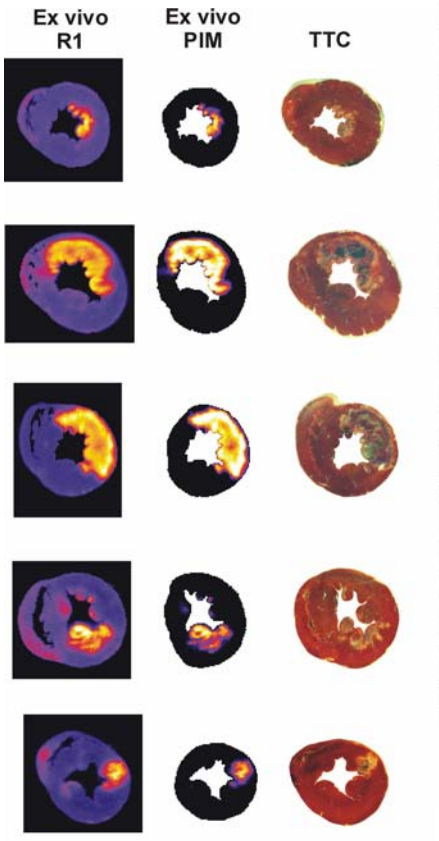

Figure 2. Representative slices from the five dogs.

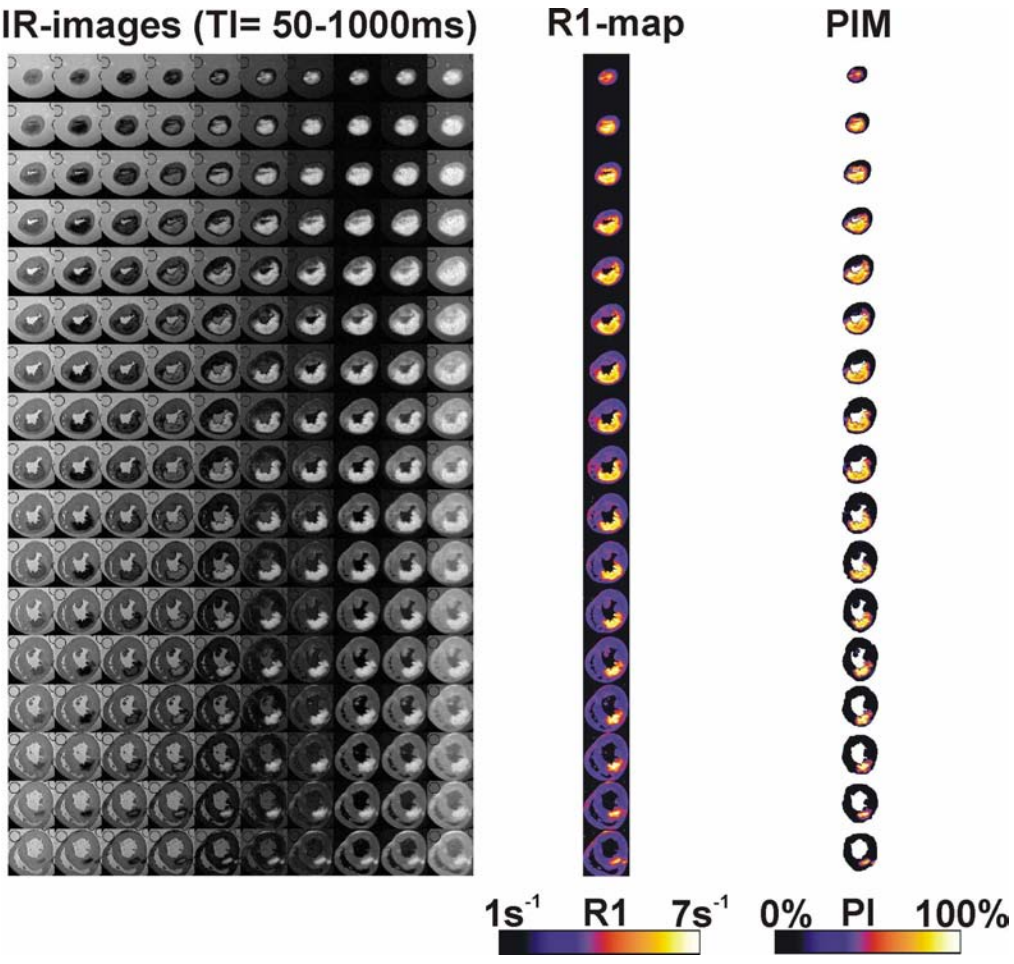

Figure 1. Ex Vivo R1-mapping and the Ex Vivo PIM.