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Accuracy of infarct measurements by inversion recovery delayed-enhancement MRI during the hyper-acute phase of myocardial infarction in rats

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Introduction

Quantification of infarct size is important in the assessment of myocardial infarction (MI) and is commonly performed by *ex-vivo* staining in experimental studies [1]. Delayed-enhancement (DE) is an accurate method for assessing infarct *in-vivo* in humans, and is increasingly used in experimental studies of chronic MI where its accuracy has been well validated [2]. However, the feasibility and accuracy of DE-MRI in measuring infarct during the hyperacute MI phase (i.e. hours) is less well-defined. Additionally, while inversion recovery (IR) is the MR sequence of choice clinically, its role has not been fully explored in small animal models.

Purpose

To compare infarct measurements by IR-based DE-MRI against tetrazolium staining during the hyperacute phase of MI in rats.

Methods

Male Wistar rats (n = 13) were anaesthetised and underwent 30 minutes of myocardial ischaemia and 2 hours of reperfusion. Short-axis DE images of the infarcted heart were acquired using a 9.4 T system (Varian) with Gd-DTPA (0.6 mmol/kg, i.v.) and a dual ECG/respiratory-gated IR sequence [3] ($\alpha = 90°$, TE = 1.5 ms, TR = 3.6 ms, TI~400 ms, FOV = 40×40 mm^2, 192×192, $\Delta Z = 1$ mm, 10-15 slices). Hearts were extracted following imaging for TTC staining and planimetry. Data were randomised and segmented by thresholding with manual corrections (ImageJ). Infarct size was expressed as a ratio to the LV (In/LV). Linear regression and Bland-Altman analysis were performed (SPSS) to compare the two methods.

Results

Figure 1 shows representative DE-MRI and TTC images. DE-MRI measurement of absolute LV and infarct sizes was systemically larger than TTC planimetry, which is most

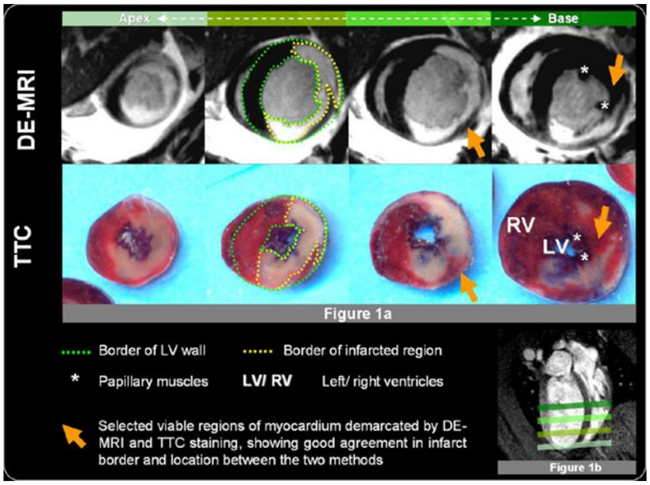

Figure 1

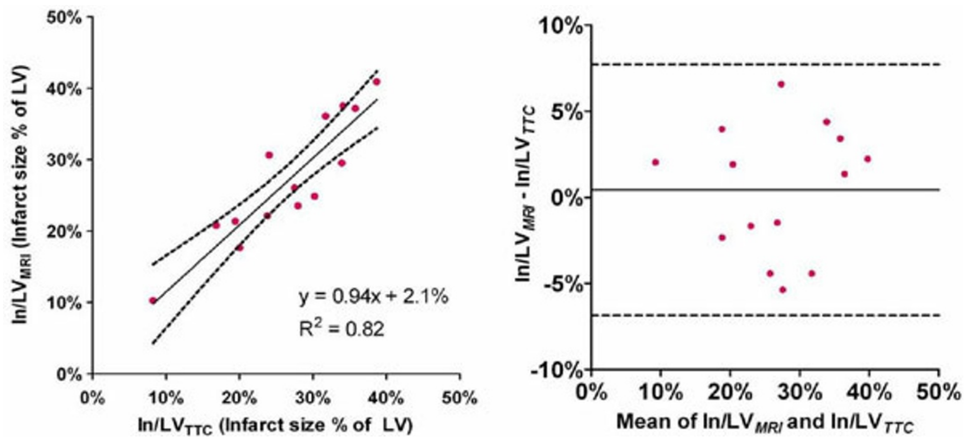

Figure 2
Correlation of *In/LV* by *DE-MRI* and TTC planimetry, illustrated here as linear regression (2a) and Bland-Altmann plots (2b). Dotted lines represent 95% confidence intervals/limits of agreement. *In/LV* measured by *DE-MRI* and *TTC* showed in non-statistically significant mean bias of +0.44 ± 3.72% (p = 0.67).

likely due to tissue shrinkage during TTC preparation. Analysis of normalised infarct size (In/LV) demonstrated a strong correlation between DE-MRI and TTC planimetry (R^2 = 0.893, F = 108.7, $p < 0.0001$; Figure 2a). Bland Altman analysis revealed negligible bias (0.4%; 95% limits of agreement = -6.6 to 7.4%; Figure 2b).

Conclusion

The application of IR-based DE-MRI in small animals has mainly been in chronic MI at lower fields (1.5-3 T) [4,5]. By employing a customised IR sequence at 9.4 T, we achieved excellent image contrast between normal and infarcted myocardium, and demonstrated that this technique can provide accurate infarct measurements during the hyper-acute phase of MI as validated by TTC planimetry. Therefore, IR-based DE-MRI may serve as a valuable tool in monitoring infarct progression and therapeutic outcome in small animal models.

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