Myocardial ECV imaging by MRI compared to myocardial ECV imaging by CT – validation in experimental acute myocardial infarction

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Background: It has recently been shown that it is possible to perform myocardial extracellular volume fraction (ECV) imaging by MR. However, validation of ECV measures by an independent standard is lacking. Therefore, we performed ECV imaging by MR and CT in an experimental model of acute myocardial infarction in order to determine the correspondence between the methods.

Methods: Dogs (n=6) underwent coronary occlusion (2h) and reperfusion (2h), followed by imaging by CT and then MR. Whole heart ECG-gated CT scanning (320 channel, Toshiba, 580 mA, 120 kV, 0.35 ms rotation time) was performed before and 30 minutes after a 1.5 ml/kg bolus and 0.03 ml/kg/min infusion of iopamidol (Isovue-370). Analogously, MR imaging (Siemens 1.5T) was performed using a T1 mapping Modified Look-Locker Inversion-recovery (MOLLI) sequence (Messroghli, 2007, JMRI) before and 30 minutes after a 0.15mmol/kg Gd-DTPA bolus followed by 0.003mmol/kg/min infusion. Also, late gadolinium enhancement (LGE) images were acquired for infarct localization. In MR, the difference in R1 (1/T1) between pre- and post-contrast administration is proportional to contrast agent concentration. Analogously, in CT, the difference in Hounsfield units (HU) between pre- and post-contrast administration is also proportional to contrast agent concentration. Also, both Gd-DTPA and CT contrast agents have a similar extracellular distribution. Thus, measurement of R1 by MR or HU by CT before and after contrast both in tissue and in blood, combined with correction for blood hematocrit, can be used to measure the extracellular volume fraction (ECV) of tissue and generate ECV images. Such measurements were undertaken in three regions of interest per animal (remote myocardium, infarcted myocardium, peri-infarct myocardium), and the ECV by MR was compared to ECV by CT. One animal did not develop infarction and thus was only measured in remote and the ischemic zone.

Results: ECV by CT and MR correlated ($R2=0.76$, $p<0.001$, n=17 measures in 6 animals, $y=0.92x + 0.08$) and the bias between MR and CT was 4.7 ± 8.3 percentage points by Bland-Altman analysis.

Conclusions: Myocardial ECV imaging by MR and CT showed a good quantitative correspondence, thus providing independent validation by CT that MR can be used to quantitatively image myocardial ECV.
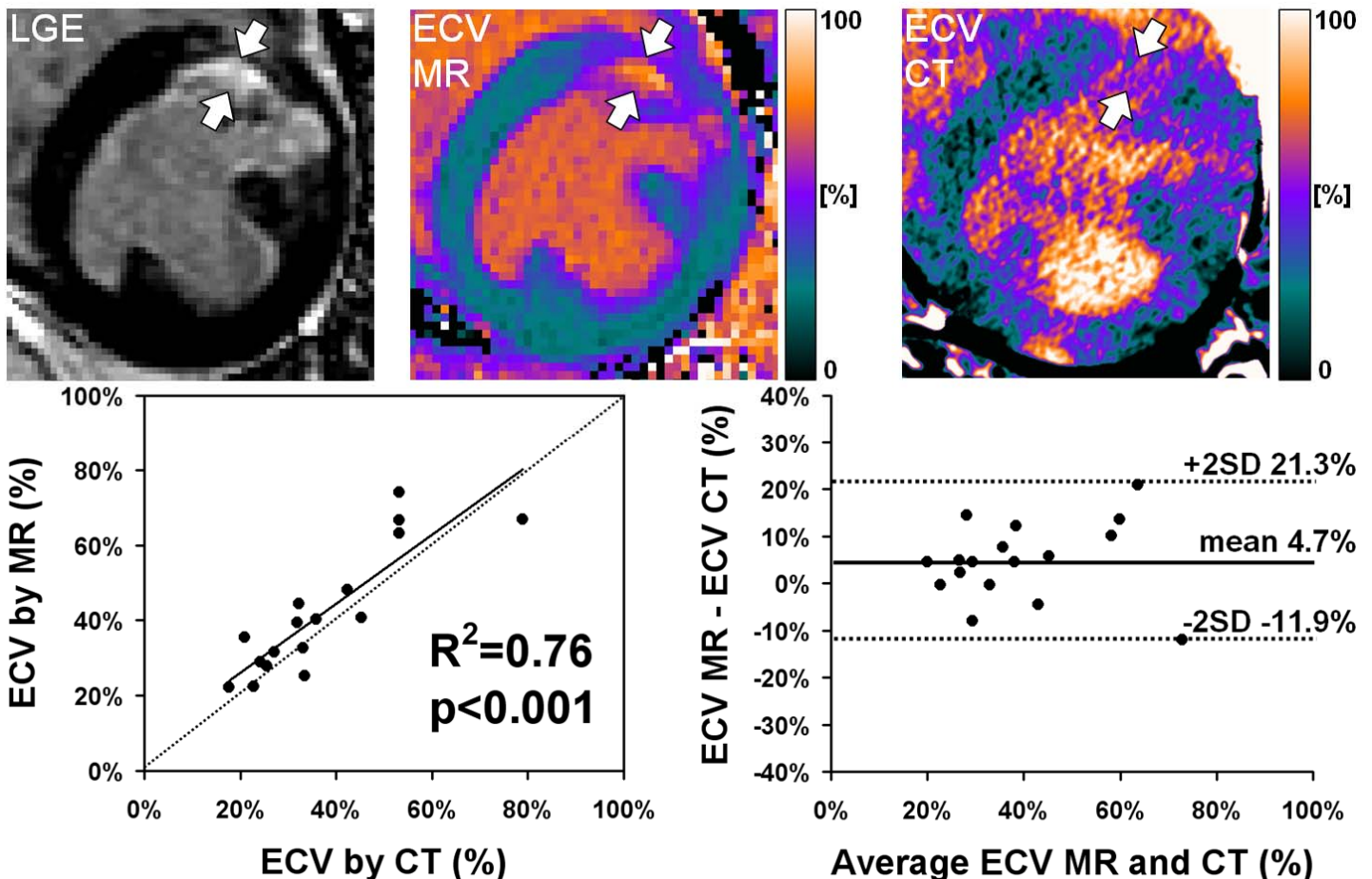
Figure: Images show late gadolinium enhancement LGE by MR, ECV by MR and ECV by CT in the same slice in the same animal. Both ECV images are displayed using the same quantitative color scale. Arrows indicate infarction. Bottom row shows linear regression (dotted line is identity) and Bland-Altman graphs of ECV by MR vs. CT.