Characterization of Chronic Myocardial Infarctions in Patients with Contrast-Free T1 Maps at 3T

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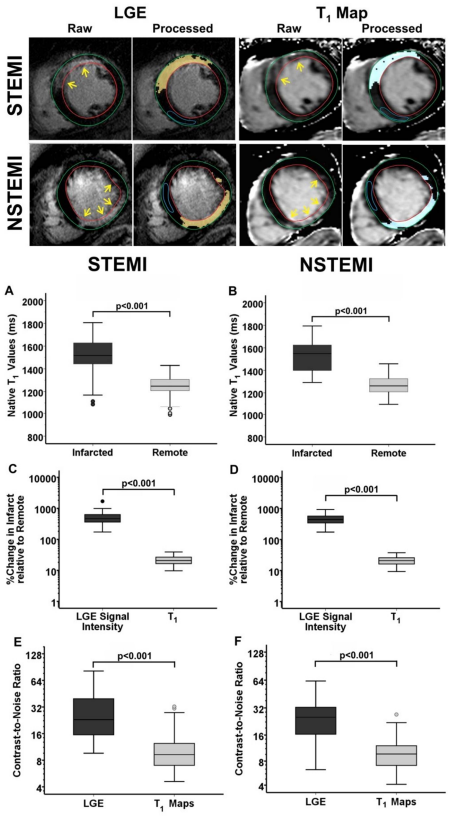
Target Audience – Scientists and clinicians studying myocardial infarction

Purpose – Late Gadolinium Enhancement (LGE) Cardiovascular Magnetic Resonance (CMR) is the gold standard for characterizing chronic myocardial infarctions (cMIs), but it is contraindicated in a significant number of patients due to the co-existence of end-stage chronic kidney disease. We investigated whether native (contrast-free) T_1 maps at 3T can be used to reliably characterize cMIs in two pilot patient populations with prior ST- elevation MI (STEMI) and non-ST elevation MI (NSTEMI).

Methods – Patients with prior STEMI (n=15) and NSTEMI (n=17) underwent CMR at a median of 13.6 years after acute MI. Breath-held 2D native T_1 maps (8 TIs with 2 Look-Locker cycles of 3+5 images; minimum TI = 120ms; TI increment = 80 ms; flip angle = 35°; bandwidth = 1085 Hz/pixel; voxel size = 1.5x1.5x8mm^3) and LGE images (IR-prepared FLASH; optimal TI to null remote myocardium; TR/TE = 6.54/3.27ms; flip angle = 20°; bandwidth = 460 Hz/pixel; voxel size = 1.2x1.2x8mm^3) were acquired. The location, size and transmurality of cMI were determined using Mean+5SD criterion relative to remote myocardium on both LGE images and T_1 maps, and compared. Native T1 values of the remote myocardium and cMI territories were measured and compared. Relative to the remote myocardium, percentage change in LGE signal intensity (LGE-SI) and native T1 value of the cMI territories were measured and compared. Contrast-to-noise ratio (CNR) of LGE images and T1 maps for detecting cMIs were also measured and compared. Two blinded independent reviewers scored the LGE images and T1 maps for the conspicuity of cMIs on the following scale: 1 – absent, 2 – uncertain, and 3 – present. Sensitivity and specificity for detecting cMIs on T1 maps using the Mean+5SD criterion and visual detection were measured.

Results – Representative native T_1 maps and LGE images from two patients, one with prior STEMI, and one with prior NSTEMI are shown in Fig.1. Relative to remote myocardium, median T_1 of the cMI was 271ms (inter-quartile range (IQR) =197-332ms) higher in STEMI patients (Infarct: 1517ms; Remote: 1247ms; p<0.001; Fig.1), and 229ms (IQR=190-323ms) higher in NSTEMI patients (Infarct: 1549ms, Remote: 1262ms; p<0.001; Fig.1). Median percentage change in LGE signal intensity (LGE-SI) of the cMI relative to remote myocardium was significantly higher than that of percentage change in T_1 in both STEMI (LGE: 465%, T_1: 21%; p<0.001) and NSTEMI (LGE: 441%, T_1: 20%; p<0.001) patients. Median CNR of LGE images was also 2.5-fold higher relative to that of T_1 maps in both STEMI (LGE: 23.1; T_1: 9.2; p<0.001) and NSTEMI (LGE: 25.3; T_1: 9.7; p<0.001) patients. LGE images and native T_1 maps were not different for measuring cMI size (STEMI – LGE: 13.8%; T_1: 14.9%; p=0.87; NSTEMI – LGE: 10.9%; T_1: 10.5%; p=0.93; Fig.2) and transmurality (STEMI – LGE: 55.6%; T_1: 60.1%; p=0.19; NSTEMI – LGE: 64.3%; T1: 60.9%; p=0.24). Bland-Altman and linear regression analyses showed good agreement between LGE images and T_1 maps for measuring cMI size (STEMI: bias=-0.4±2.1%; R^2=0.97; NSTEMI: bias=-1.1±3.9%; R^2=0.87) and transmurality (STEMI: bias=1.5±2.9%; R^2=0.99; NSTEMI: bias=-2.2±7.4%; R^2=0.71). Mean score for LGE images was significantly higher than those for T_1 maps in both cases (STEMI: 1.96±0.93 vs. 1.71±0.71, p=0.021; NSTEMI: 1.83±0.93 vs. 1.66±0.89, p=0.024. Sensitivity and specificity of native T_1 maps for detecting cMIs based on threshold criterion were 93% and 97% respectively (STEMI); and 93% and 92% respectively (NSTEMI). Sensitivity and specificity of native T_1 maps for visual detection of cMI were: 61% and 85% (STEMI); and 67% and 90% (NSTEMI).

Conclusions – Semi-automated threshold analysis of native (contrast-free) T_1maps can reliably detect and characterize cMIs patients with a prior STEMI or NSTEMI. Further increase in image contrast may be necessary to improve visual detection sensitivity of chronic MI territories to the levels observed with LGE.



LGE images from a patient with prior STEMI (infarct age = 18.5 years) and NSTEMI (infarct age = 25.6 years) are shown. Median native T_1 of the infarct was significantly elevated in both STEMI and NSTEMI patients. Percentage change in LGE signal intensity and LGE infarct-to-remote CNR were significantly higher than those of T_1 maps.

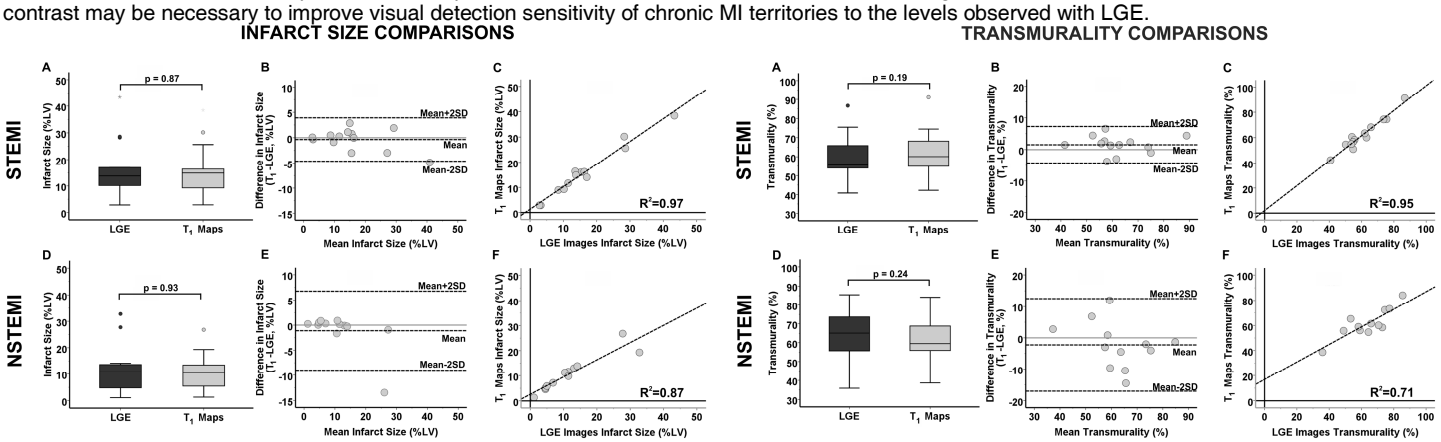


Figure 2: Native T_1 maps and LGE images were not different for measuring chronic infarct size and transmurality in both STEMI and NSTEMI patients. Bland-Altman and linear regression analyses further showed good agreement for measuring infarct size and transmurality.