Accuracy and precision of chronic myocardial infarct characterization with native T1 mapping at 3T

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Background
Native T1-maping at 3T has been shown to reliably characterize chronic myocardial infarctions (MIs). In this study, we evaluated the accuracy and precision of different thresholding techniques and visual delineation for characterizing chronic MIs on native T1 maps at 3T.

Methods
Canines (n=23) underwent CMR at 4 months following MI. Native T1 maps (MOLLI; 8 TIs with 2 inversion blocks of 3+5 images; minimum TI=110ms; ΔTI=80ms; TR/TE=2.2/1.1ms) and Late Gadolinium Enhancement images (LGE; IR-prepared FLASH; TI optimized to null remote myocardium; TR/TE=3.5/1.75ms) were acquired at 3T. Infarct size and transmurality measured using Mean + 2 standard deviations (SD), Mean+3SD, Mean+4SD, Mean+5SD, Mean+6SD, Otsu’s, and visual delineation methods were compared against the Mean+5SD LGE measurements, and their relative diagnostic performance was evaluated.

Results
Relative to LGE images, mean infarct size and transmurality measured from native T1 maps were significantly overestimated by Mean+2SD, Mean+3SD, and Mean+4SD techniques (p<0.001, for all cases). Mean+6SD criterion and visual delineation significantly underestimated infarct size (p<0.001 for both cases) and transmurality (p=0.01 for Mean+6SD; p<0.001 for visual) on native T1 maps. Otsu’s technique showed no difference for measuring infarct size on native T1 maps compared to LGE images (p=0.27), but it overestimated the infarct transmurality (p<0.001). Mean+5SD criterion showed no difference for measuring either infarct size (p=0.61) or transmurality (p=0.81) on T1 maps relative to LGE images. Mean CNR of LGE images was nearly 4-fold higher than that of native T1 maps (p<0.001). Mean+5SD criterion for detecting chronic MIs on native T1 maps at 3T showed the strongest diagnostic performance (area-under-curve=0.99, p<0.001), while visual delineation showed the weakest diagnostic performance (area-under-curve=0.84, p<0.001).

Conclusions
Threshold-based analysis using Mean+5SD criterion can accurately and precisely estimate the size, location and transmurality of chronic MIs on native T1 maps as reliably as LGE at 3T.

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Figure 1 Infarcted myocardium (highlighted pixels) detected using the Mean+5SD criterion on LGE images, and different thresholding criteria and visual delineation techniques on T1 maps are shown. Relative to LGE images, significant over-estimation in the spatial extent, AHA-segmental infarct size, and transmurality could be observed with Mean+2SD and Mean+3SD techniques on T1 maps. Native T1 maps showed closer agreement to LGE images when Mean+4SD, Mean+5SD, and Otsu’s techniques were used. Visual delineation significantly under-estimated the spatial extent and transmurality of the infarction on T1 maps.

Figure 2 Bar plots compare the mean infarct size (A) and transmurality (B) measured using different thresholding and visual delineation techniques on native T1 maps to those measured on LGE images using Mean+5SD criterion. Bar plots comparing the accuracy and precision of different thresholding and visual delineation techniques to detect chronic MI are also shown (C). Of all the techniques used for infarct characterization on T1 maps, Mean+5SD criterion showed the best agreement to LGE images. ROC analysis (D) showed the strongest diagnostic performance for Mean+5SD technique, and the weakest diagnostic performance for visual delineation.