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Differentiation of acutely infarcted myocardium by quantitative differences in T1 relaxation times using Shortened Modified Look-Locker Inversion Recovery (ShMOLLI) in 3T

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Introduction

T1-mapping of the myocardium can potentially detect, quantify and monitor pathology without contrasting agents. One proven method is the MOLLI (Modified Look-Locker Inversion-recovery) technique, offering single-slice T1-mapping based on three sequential inversion-recovery (IR)-prepared experiments in a 17-heartbeat breath-hold. As long imaging time can limit clinical application, we sought to assess the ability of a shorter variant (ShMOLLI) to differentiate acutely infarcted from normal myocardial tissue at 3 T.

Materials and methods

4 patients (3 males; age 53 ± 10 years) underwent CMR imaging at 3 T (TRIO, SIEMENS) including MOLLI [Messroghli. JMRI. 2007:26(4):1081-6] and ShMOLLI sequences to assess myocardial T1 values at a single representative slice. ShMOLLI was implemented as 3 IR experiments split over 9 heartbeats (separated by only one heartbeat) to collect 5+1+1 SSFP images with varying TI (typically 110-5000 ms, TE = 1.1 ms, TR = 206 ms, flip angle = 35°, FOV = 340 × 116 mm, matrix 192 × 116, interpolation = 2). ShMOLLI samples from the second and third IR are taken into account only if the estimated T1 is shorter than the R-R interval, and they improve non-linear fit. Post-processing involved manual segmentation of the myocardium followed by calculation of the distribution of T1 values. These were split into 2 component Gaussians to assess the proportion of infarcted myocardium and compared to late gadolinium (LG) images obtained 4-16 days earlier.

Results

T1-maps and segmentations produced by either method did not differ visually (Fig. 1: example of anterior transmural infarct). Well-separated peaks were detected with T1-estimates for infarcted and remote normal myocardium (1414 ± 50 ms vs. 1215 ± 47 ms; relative difference 16%, $P < 0.0001$). The estimated proportion of the infarct was 44 ± 10% with good agreement between ShMOLLI and MOLLI (2.5 ± 2.5% difference; 6.3% max). ShMOLLI maps had on average 20% more variability than MOLLI maps. The average difference from LG infarct size was 3 ± 13% (range -8.9 to +20%).

Discussion

These preliminary data highlight the potential of ShMOLLI T1-mapping to characterise myocardial infarction without the need for gadolinium contrast at 3 T. The infarct tissue is visible on the scanner console immediately after imaging. The clear separation of T1 distributions may facilitate objective differentiation of lesions from normal myocardium. ShMOLLI offers a two-fold increase in speed of acquisition without significant impact on the segmentation accuracy. Both methods had moderate agreement with LG, likely due to the time difference betweens scans, interobserver variability and slice positioning differences.

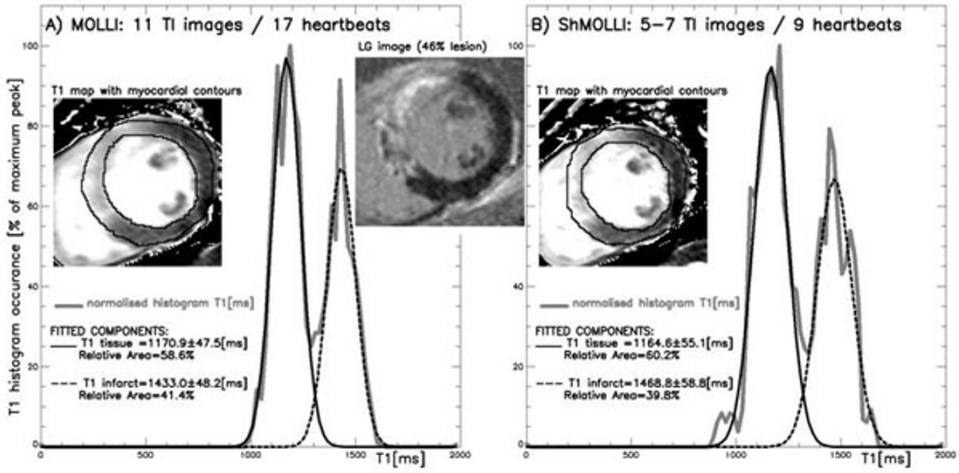

Figure 1

Conclusion

T1-mapping with the proposed ShMOLLI method generates robust, quantitative single breath-hold T1 maps of the myocardium that distinguish between acute infarct and normal tissue.