Assessment of the gray zone: a comparison of two quantitative methods in heart failure patients

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Introduction

The MR-based assessment of the peri-infarct area in myocardial infarction may provide valuable clinical information and could aid in determining which patients could benefit from cardioverter-defibrillator therapy [1]. Several methods based on the assessment of the gray zone in late gadolinium enhancement (LGE) have been presented [1-3]. In a recent, quantitative approach, the gray zone is identified via an automated segmentation of a plot of M0 over T1*, which are obtained from a Look Locker T1* mapping sequence [4,5]. However, a shortcoming of this method is the presence of cardiac motion, which may blur the resulting T1 maps and obscure the relatively small peri-infarct zone. For the present study, a segmentation based on M0 over T1 was implemented, where both parameters were obtained using a modified Look Locker (MOLLI) T1 mapping sequence [6] including cardiac motion correction. First in vivo results obtained in patients with known ischemic cardiomyopathy (ICM) are shown and compared with the results obtained with a conventional Look Locker (LL) sequence.

Materials and Methods

Eight male patients (64 ± 9.1 yrs) with known ICM underwent CMR on a 1.5T MR-scanner (Philips Healthcare, Best, Netherlands). Approximately 15-20 minutes after injection of 0.2 mmol/kg gadobenate dimeglumine, standard LGE imaging was performed followed by two sequences to assess the gray zone covering the infarct area. The LL and MOLLI sequences were adapted from [7] and [6], respectively. Sequence parameters included: 0.96 × 0.96 mm² in-plane resolution in multiple slices covering the whole ventricle, LL: 16 phases, 100 ms phase interval, slice thickness 10mm, MOLLI: ECG triggered acquisition in mid-diastole only, 200 ms acquisition window, 11 inversion delays, thickness 8mm. Manual segmentation of infarct, healthy myocardium, and gray zone was performed. M0 over T1 plots for LL and MOLLI were compared with LGE findings.

Results

One selected *in vivo* example (viability image) is shown in Fig. 1[a]. The resulting T1 maps obtained with LL and MOLLI are shown in Fig. 1[b] and [c], respectively. The T1 maps obtained with MOLLI exhibited less blurring and a better definition of the myocardial borders compared with LL (dotted circle). A plot of M0 over T1 is shown for both sequences in Fig. 2[a] and [b], respectively. The case shown suggests significant gray zone in the LL M0/T1-plot while no gray zone was seen in LGE and MOLLI analysis. Reduced overall scattering of the values and a more compact representation of the individual species (healthy myocardium, scar, and gray zone if present) was observed using MOLLI with cardiac motion correction.

Discussion and Conclusion

The MOLLI sequence with cardiac motion correction provides T1 maps with improved delineation of the myocardial border when compared with a conventional LL approach. Furthermore, less scattering of the values in the M0 over T1 plot was observed, and a more compact representation of the individual species (healthy myocardium, scar, and gray zone) was obtained. Therefore, MOLLI may represent a better basis for the determination of the gray zone extent based on a clustering of M0/T1. A fully automated clustering should be implemented as a future goal, and examinations should be performed in a larger patient cohort.

References

[1] Roes, et al., Circ Cardiovasc Imaging 2009;2:183-190. [2] Schmidt, et al., Circulation 2007, 115:2006–2014. [3] Yan, et al., Circulation 2006, 114:32–39. [4] Connelly, et al., JMRI 2009, 30:771-7 10. [5] Detsky, et al., IEEE Med Imaging 2009, 28:1606-14. [6] Messroghli, et al., MRM 2007, 58:34-4. [7] Look & Locker. Rev Sci Inst 1970, 41:250.

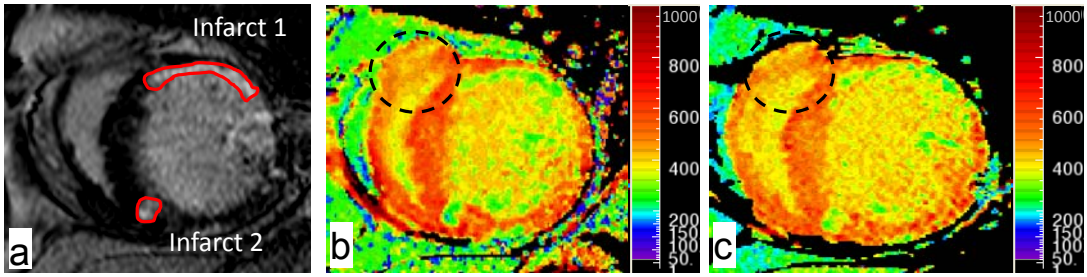

Fig. 1: LGE image (a), Look Locker T1 map (b), and MOLLI T1 map (c).

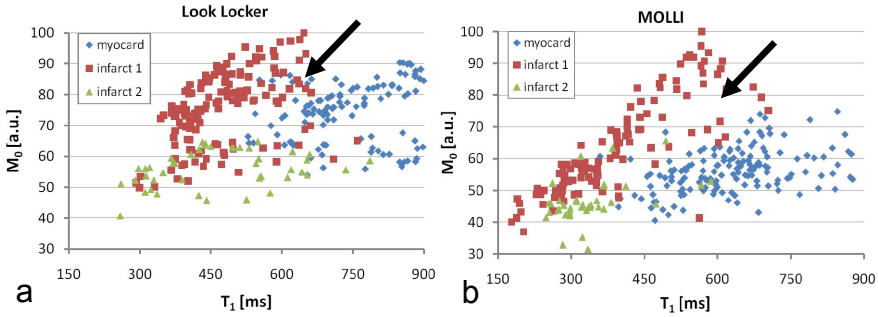

Fig. 2: M0/T1 map for Look Locker (a) and MOLLI (b). Gray zone is characterised by overlapping M0/T1 regions of healthy myocardium and infarct (arrows).