

AUTOMATED AREA AT RISK DETECTION USING MYOCARDIAL T1 MAPS ACQUIRED PRE- AND POST CONTRAST AGENT ADMINISTRATION

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Introduction

The quantitative MR-based assessment of the peri-infarct area (grey zone) in myocardial infarction may provide valuable clinical information to determine which patients might benefit from cardioverter-defibrillator therapy [1]. Recently, assessment of the grey zone via an automated clustering method was proposed which was based on a scatter plot of T1-weighted signal intensity over quantitative T1 both obtained after administration of contrast agent [2,3]. A shortcoming of this method is that the contrast in T1-weighted signal intensity images and T1 maps is very similar making the method prone to inaccuracy. In the present study, a clustering algorithm was implemented to automatically segment blood pool, scar core, healthy myocardium and grey zone based on two quantitative T1 maps acquired before and after contrast agent injection. First in vivo results obtained in patients with known ischemic cardiomyopathy (ICM) are shown and compared to late enhancement images (LGE).

Materials and Methods

5 male patients (69 ± 14 yrs) with known ICM underwent CMR on a 1.5T MR-scanner (Philips Healthcare, Best, Netherlands). An inversion recovery MOLLI T1 map [4] was acquired pre- and 20 - 25 minutes post- injection of 0.2 mmol/kg gadobutrol ($1.8 \times 1.8 \times 8$ mm³ resolution, 11 inversion delays, ECG triggered acquisition in mid-diastole, 170 ms acquisition window, 18s breathhold). Automated segmentation of blood pool, infarct area and healthy myocardium was performed using a clustering algorithm (Fuzzy c-means, Gustafson-Kessel modification) on a scatter plot of pre- vs. post-T1 values of the entire left ventricle (see Fig.1). Grey zone is defined as points with probability of belonging to both infarct and healthy myocardium clusters. Approximately 15-20 minutes after contrast agent injection standard LGE imaging was performed for comparison.

Results

The characteristic shift of myocardial T1 values after contrast agent administration is shown in Fig 1. Neither T1 map on its own exhibits a clear cut-off value that would identify grey zone. The scatter plot shows the three clusters that are formed and grey zone can be separated from the blood pool signal. Two in vivo examples of the resulting segmented left ventricle and corresponding LGE images are shown in Fig. 2.

Discussion and Conclusion

Automated segmentation of blood pool, infarct area, healthy myocardium and grey zone is possible using two T1 maps, one acquired before and another after contrast agent administration. Good agreement between late enhancement images and automated segmentation using the clustering algorithm is observed. A current limitation of the technique is artifacts from noise and breathing motion that can blur the expected clusters. Future studies could include navigators and dedicated clustering algorithms.

References: [1] Roes, et al., Circ Cardiovasc Imaging 2009;2:183-190.

[2] Detsky, et al., IEEE Med Imaging 2009, 28:1606-14. [3] Voigt et al., Proc ISMRM 2011, 3385. [4] Messroghli, et al., MRM 2007, 58:34-4.

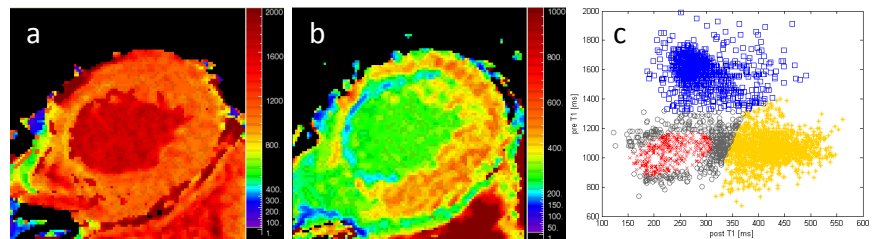


Figure 1: T1 maps before contrast agent administration (a) and after (b) and the corresponding scatter plot used for clustering (c). Different clusters for blood pool (blue), scar core (red), healthy myocardium (yellow) and overlapping grey zone (grey) are shown (see also Fig. 2b).

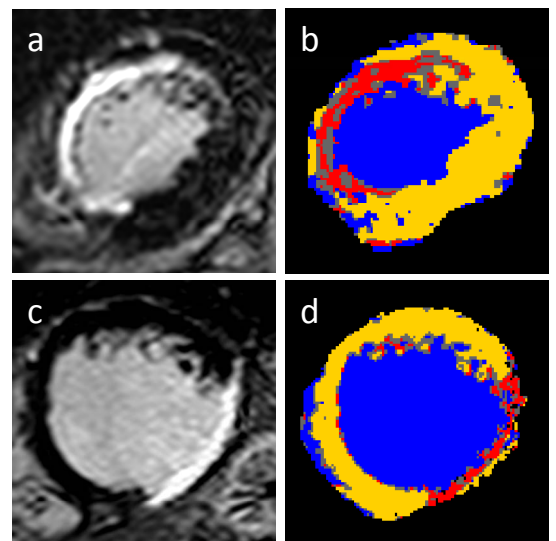


Figure 2: LGE images of two selected patients (a, c) and corresponding automated segmentation (b, d). Good agreement between LGE and clustering results is observed. Colors as in Fig. 1.