MOLLI T$_1$-Mapping for Assessment of Acute Myocardial Infarction and Tako-Tsubo Cardiomyopathy

Donnie Cameron[1], David Higgins[2], Baljit Jagpal[1], Margaret Bruce[1], Nishat Siddiqi[1], Christian Stehning[3], Michael Frenneaux[1], Thomas Redpath[1], and Dana Dawson[1]

[1]The University of Aberdeen, Aberdeen, Scotland, United Kingdom, [2]Philips Healthcare, Guildford, United Kingdom, [3]Philips Research, Hamburg, Germany

Introduction: We have previously shown that carefully optimised Modified Look-Locker Inversion Recovery (MOLLI) [1] at 3T can provide a robust T$_1$ relaxation time measurement in the myocardium. In this study, we aimed to assess the utility of MOLLI to identify abnormal myocardium in two different pathologies: acute myocardial infarction (MI) and acute tako-tsubo cardiomyopathy, each compared to normal myocardium.

Methods: Three groups were recruited for this study: a set of 9 normal volunteers; 6 patients at day 7 post acute MI; and 1 patient at day 3 during acute tako-tsubo cardiomyopathy. All subjects were scanned on a 3 Tesla MR scanner (Philips Achieva) using a conventional MOLLI sequence (3-3-5 scheme with 3 RR cycles per pause, α = 35°). In patients MOLLI images were acquired prior to the administration of contrast. In all cases, 6 short-axis images - 2 basal, 2 mid-cavity and 2 apical - were acquired in order to conform to the standard 17 segment myocardial model [2] omitting the apical segment. T$_1$ calculation was performed using IDL 6.0 (ITT, Boulder, CO, USA) and ROIs were manually drawn for each segment using MIPAV 5 (CIT, Bethesda, MA, USA). The T$_1$ value for each segment was calculated from the mean of the 2 short axis slices acquired at each level. Abnormal regions were initially identified using a combination of T$_2$-weighted TSE with fat suppression and late gadolinium enhancement (LGE) images prior to segmented T$_1$ calculation. The corresponding segments were then grouped according to status [1-normal, 2-LGE positive, 3-area-at-risk-(AAR)-minus-LGE area, 4-remote myocardium (outwith the AAR seen on T$_2$W TSE) in MI and 5-dyskinetic myocardium, 6-preserved wall motion in tako-tsubo] and position relative to the long-axis (basal, mid-cavity, apical). Statistical analysis was performed in SPSS 19; ANOVA with Games-Howell post-hoc testing was used in order to establish any significant differences between the groups. Independent samples t-tests (and Mann-Whitney U tests in the case of data that were not normally distributed) were then conducted between the groups of interest.
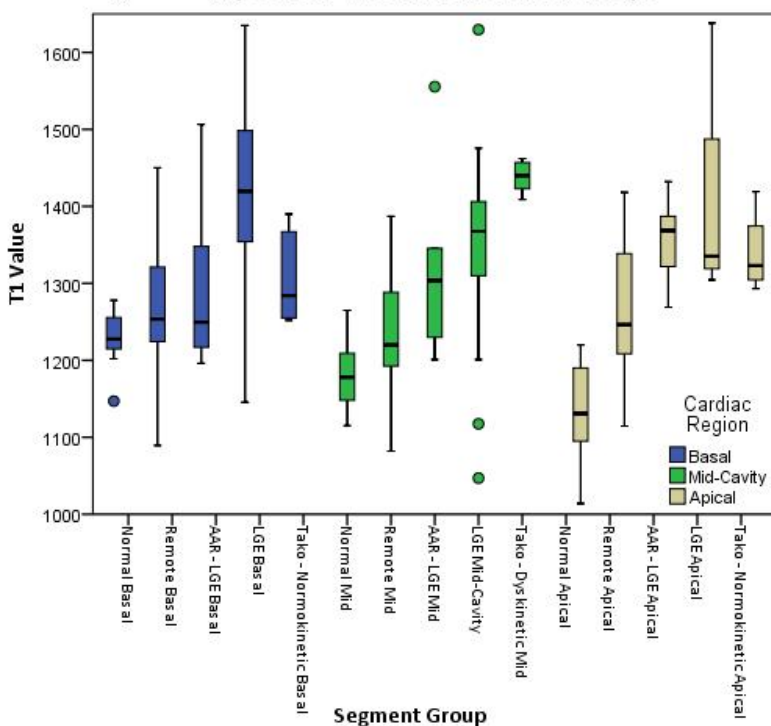

Figure 1 Myocardial T1 Variation Between Groups

Table 1. Significant T$_1$ Differences Between Groups		
Region	**Comparison [Mean±SD (ms)]**	**Significance**
Base	Normal vs. LGE [1229±38 vs. 1426±140]	p=0.0004
	Normal vs. Tako Preserved [1229±38 vs. 1305±59]	p=0.023
Mid-Cavity	Normal vs. Remote [1180±44 vs. 1241±88]	p=0.048
	Normal vs. AAR - LGE [1180±44 vs. 1323±126]	p=0.037
	Normal vs. LGE [1180±44 vs. 1345±138]	p=0.0003
	Normal vs. Tako Dyskinetic [1180±44, 1439±21]	p=0.0000000003
Apex	Normal vs. Remote [1114±92, 1246±139]	p=0.013
	Normal vs. AAR - LGE [1114±92 vs. 1357±51]	p=0.000005
	Normal vs. LGE (MW) [1114±92) vs. 1403±157]	p=0.005
	Normal vs. Tako Preserved [1114±92 vs. 1340±55]	p=0.0003

MW = Mann-Whitney U test

Results: A boxplot demonstrating the variation in T$_1$ across all groups is shown in Figure 1- with dots representing outliers. Table 1 shows significant differences between groups. In acute MI, T$_1$ was significantly higher in segments which subsequently were shown to retain Gadolinium (LGE) versus normal myocardium. The remainder of the AAR (that did not retain Gadolinium) as mapped by the T$_2$W TSE also showed significantly elevated T$_1$, as did the remote myocardium in both mid-cavity and apical segments (although this did not reach significance in basal segments), suggesting that T$_1$ mapping is superior in detecting acutely abnormal myocardium compared to standard assessment. The tako-tsubo dyskinetic segments had significantly higher T$_1$s than normal myocardium and these T$_1$ values were also significantly higher compared to acutely oedematous infarcted myocardium. The tako-tsubo segments with preserved wall motion also had significantly higher T$_1$ values compared to normal myocardium.

Conclusions: T$_1$ maps sensitively delineate acutely oedematous, abnormal myocardium in both acute MI and acute tako-tsubo cardiomyopathy, providing a superior evaluation compared to current T$_2$W assessment.

References

[1] Messroghli DR et al. Magn Reson Med. 2004, 52(1):141-6
[2] Cerqueira MD et al. Circulation. 2002, 105:539-42