Joint myocardial T1 and T2 mapping

The Harvard community has made this article openly available. Please share how this access benefits you. Your story matters

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Published Version</td>
<td>doi:10.1186/1532-429X-17-S1-Q1</td>
</tr>
<tr>
<td>Citable link</td>
<td><a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos:14065497">http://nrs.harvard.edu/urn-3:HUL.InstRepos:14065497</a></td>
</tr>
<tr>
<td>Terms of Use</td>
<td>This article was downloaded from Harvard University’s DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA">http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA</a></td>
</tr>
</tbody>
</table>

Joint myocardial $T_1$ and $T_2$ mapping

Mehmet Akçakaya$^1$, Sebastian Weingärtner$^{1,2}$, Tamer A Basha$^1$, Sébastien Roujol$^1$, Reza Nezafat$^1$

From 18th Annual SCMR Scientific Sessions
Nice, France. 4-7 February 2015

Background
Recent studies suggest that quantitative myocardial $T_1$ mapping allows assessment of focal and diffuse fibrosis in the myocardium [1]. Quantitative $T_2$ mapping has also been proposed to overcome challenges associated with $T_2$ weighted imaging [2]. These maps are traditionally acquired with different sequences, necessitating image registration to evaluate them jointly. A sequence that can jointly estimate $T_1$ and $T_2$ maps has been proposed [3], but it requires multiple relaxation cycles, which necessitates a lengthy free-breathing acquisition. In [4], an alternative joint estimation sequence was proposed based on the inversion-recovery SSFP curve. In this study, we sought to develop a saturation-recovery image registration to evaluate them jointly. A sequence that can jointly estimate $T_1$ and $T_2$ maps has been proposed [3], but it requires multiple relaxation cycles, which necessitates a lengthy free-breathing acquisition. In [4], an alternative joint estimation sequence was proposed based on the inversion-recovery SSFP curve. In this study, we sought to develop a saturation-recovery

![Figure 1](http://www.jcmr-online.com/content/17/S1/Q1)

Figure 1. a) The sequence diagram for the proposed technique. A saturation pulse is applied in every R-R interval to eliminate the magnetization history. The longitudinal magnetization then recovers for $T_{sat}$. Subsequently a $T_2$-prep with echo length $TE_{prep}$ is applied to generate the additional $T_2$ weighting, after which a single shot SSFP image is acquired. b) The mapping sequence acquires the first image with no magnetization preparation (corresponding to $T_{sat} = \infty$ and $TE_{prep} = 0$), followed by 12 images (3 are shown) acquired with different $T_{sat}$ and $TE_{prep}$ values. The major characteristics of the longitudinal magnetization signal curve are depicted under the pulse sequence diagram.
based heart-rate independent sequence that can be acquired in a breath-hold and that allows for simultaneous estimation of quantitative $T_1$ and $T_2$ maps.

Methods

The sequence diagram is depicted in Figure 1. At every heartbeat, a saturation pulse is applied to eliminate the magnetization history. The longitudinal magnetization then recovers for $T_{\text{sat}}$ based on the $T_1$ value. Subsequently a $T_2$-prep pulse [5] with echo length $T_{\text{prep}}$ is applied to generate the additional $T_2$ weighting, after which a single shot SSFP image is acquired. The process is repeated for 13 heartbeats with various ($T_{\text{sat}}^k$, $T_{\text{prep}}^k$) corresponding to heartbeat $k$, to sample different $T_1$-$T_2$ weighted images. The first heartbeat is acquired with no magnetization preparation.

The $T_1$ and $T_2$ maps were estimated jointly by voxel-wise least squares fitting to a 4-parameter signal model, $A \cdot (1 - \exp(-T_{\text{sat}}^k/T_1)) \cdot \exp(-T_{\text{prep}}^k/T_2) + B$. Phantom imaging of 14 vials with different $T_1/T_2$ values were performed and compared to inversion-recovery and CPMG spin-echo references, respectively. Breath-held in-vivo imaging was performed on 5 healthy adult subjects, and the maps were compared to SASHA $T_1$ maps [6] and to $T_2$ maps [7].

Results

Phantom imaging resulted in $T_1$ and $T_2$ values not significantly different than the references ($P = 0.481$ and 0.479 respectively). Example in-vivo $T_1$ and $T_2$ maps are depicted in Figure 2, comparing various techniques. The $T_1$ and $T_2$ values were in good agreement ($1211 \pm 82$ ms vs. $1210 \pm 92$ ms for $T_1$; $49.0 \pm 5.8$ ms and $47.3 \pm 6.5$ ms for $T_2$).

Conclusions

The proposed sequence allows for the simultaneous estimation of accurate and jointly registered quantitative $T_1$ and $T_2$ maps with similar accuracy and precision to saturation-based $T_1$ mapping and to $T_2$ mapping of same duration.

Funding

NIH:K99HL111410-01; R01EB008743-01A2.
Authors’ details
1Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA. 2Computer Assisted Clinical Medicine, University Medical Center Mannheim, Heidelberg University, Mannheim, Germany.

Published: 3 February 2015

References

doi:10.1186/1532-429X-17-S1-Q1

Cite this article as: Akçakaya et al. Joint myocardial T1 and T2 mapping. Journal of Cardiovascular Magnetic Resonance 2015, 17(Suppl 1):Q1.