Comparing 3D-QALAS with MOLLI and Multi-Echo for in-vivo myocardial T1 and T2 quantification

Sofia Kvernby\textsuperscript{1,2}, Marcel Warntjes\textsuperscript{1,2}, Carl-Johan Carlhäll\textsuperscript{1,2}, Jan Engvall\textsuperscript{1,2}, and Tino Ebbers\textsuperscript{1,2}

\textsuperscript{1}Institution of Medical and Health Sciences, Linköping, Östergötland, Sweden, \textsuperscript{2}Center for Medical Image Science and Visualisation, Linköping, Östergötland, Sweden

TARGET AUDIENCE
People interested in cardiac MRI, tissue characterization and quantitative MRI.

PURPOSE
Recently, a novel method has been developed for 3D interleaved T1 and T2 quantification of the entire myocardium within one single breath hold, 3D-QALAS (Kvernby et al, 2014). In this work we validate this method in-vivo by making a comparison with MOLLI-sequence for myocardial T1-mapping and multi-echo acquisitions for T2-mapping.

METHODS
The 3D-QALAS sequence is based on a 3D spoiled Turbo Field Echo sequence using inversion recovery with interleaved T2 preparation pulse. Quantification of both T1 and T2 in a volume of 13 slices covering the entire left ventricular myocardium with a resolution of $2.0 \times 2.0 \times 6.0$ mm was obtained during a single breath hold of 15 heartbeats with 3D-QALAS. Healthy volunteers with no history of cardiovascular or pulmonary disease, underwent three 3D-QALAS scans in order to investigate the precision and accuracy of the method. Images were acquired in left ventricular short axis orientation.

For comparison, a 2D 3-3-5 MOLLI acquisition (Messroghli et al, 2004) was performed for myocardial T1 quantification and a 2D two-point multi-echo GraSE EPI sequence was used for quantification of T2. The 2D mid-ventricular short axis slices were acquired with a resolution of $2.0 \times 2.0 \times 10.0$ mm. T1 and T2 values were obtained from four ROIs positioned in different sections in a mid-ventricular short axis slice.

RESULTS
The in-vivo T1 and T2 relaxation time maps of 3D-QALAS showed good agreement with the MOLLI and Multi-Echo reference methods. Results from the different methods are shown for a typical healthy volunteer in Table 1. Associated images corresponding to the different relaxation time mapping methods are shown in Figure 1.

DISCUSSION AND CONCLUSION
Relaxation times measurements obtained with 3D-QALAS correspond well with data from existing 2D mapping methods and allows a fast acquisition that provides information about both T1 and T2, making the method clinically applicable to a broader spectrum of diseases.

REFERENCES
Kvernby et al, 3D-Qantification using an interleaved Look-Locker acquisition sequence with T2-prep pulse (3D-QALAS), SCMR 2014
Messroghli et al, Modified Look-Locker Inversion Recovery (MOLLI) for high-Resolution T1 Mapping of the Heart, MRM 2004

Table 1. In-vivo data from a typical healthy volunteer measured with 3D-QALAS, MOLLI and Multi-Echo. Relaxation time measurement in different sections of the myocardium, displayed as mean value and standard deviation from a specific ROI based on three repeated measurements.

<table>
<thead>
<tr>
<th>Case</th>
<th>Section</th>
<th>3D-QALAS T1 (T1 (ms))</th>
<th>MOLLI T1 (T1 (ms))</th>
<th>3D-QALAS T2 (T2 (ms))</th>
<th>T2-ME (T2 (ms))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>Septal</td>
<td>1117.8 ± 33.0</td>
<td>1123.0 ± 53.7</td>
<td>55.2 ± 3.3</td>
<td>50.1 ± 11.2</td>
</tr>
<tr>
<td></td>
<td>Anterior</td>
<td>1066.6 ± 39.8</td>
<td>1095.7 ± 28.0</td>
<td>54.0 ± 2.2</td>
<td>49.1 ± 6.4</td>
</tr>
<tr>
<td></td>
<td>Lateral</td>
<td>1052.3 ± 41.8</td>
<td>1050.3 ± 77.0</td>
<td>54.2 ± 3.0</td>
<td>48.8 ± 11.1</td>
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<tr>
<td></td>
<td>Posterior</td>
<td>1047.0 ± 37.8</td>
<td>1060.7 ± 55.7</td>
<td>52.6 ± 7.2</td>
<td>50.6 ± 11.4</td>
</tr>
<tr>
<td>Averages</td>
<td></td>
<td>1070.9 ± 32.3</td>
<td>1082.4 ± 33.3</td>
<td>54.0 ± 1.0</td>
<td>49.7 ± 0.8</td>
</tr>
</tbody>
</table>

Figure 1. Quantitative images of a healthy volunteer. From left to right: T1-map with 3D-QALAS, T2-map with 3D-QALAS, T1-map with MOLLI and T2-map with two-point Multi-Echo.