Abstract: P645

Reliability of left ventricular dyssynchrony indices by three-dimensional speckle-tracking echocardiography: the impact of intentional impairment of image quality

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On behalf: N/A

Topic(s):
3D Echocardiography

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Background: Three-dimensional echocardiography (3DE) derived left ventricular (LV) systolic dyssynchrony index (SDI) has been proposed as a reliable measure to assess LV mechanical dyssynchrony (MD) and help guide cardiac resynchronization thereby. Recently, 3D speckle-tracking echocardiography (3D-STE) has emerged as a novel method in the evaluation of LVMD. 3D-STE is influenced by image quality, but little is known about the impact of this on 3D-STE derived LV dyssynchrony indices.

Purpose: To assess the impact of intentionally impaired image quality on 3D-STE derived LV dyssynchrony indices.

Methods: 3DE was perfomed using a EPIQ7 equipped with X5-1 xMATRIX cardiac probe in 18 healthy volunteers (age 28 ± 6 years, 55.5% men) with good echocardiographic windows. Two gated 3DE full-volume data sets of the LV were obtained. One of these was acquired with optimal quality, the other with intentionally impaired quality images. Quality was impaired by including images with echo drop out, shadow artefacts, or poor visualization of the endocardium. Both acquisitions were free of stitching artefacts and the frame rate was maintained similar. Measures (normalized to cardiac cycle length) were: volume-based SDI (defined as the standard deviation of time to minimum segmental volumes over 16-LV segments), strain-based systolic dyssynchrony indices (calculated as the standard deviation of time to peak segmental strain over 16 LV-segments) and volume- and strain-derived dispersion indices. The acquisition protocol was repeated on the same day to assess the test-retest repeatability. The intraclass correlation coefficient was used as a measure of reliability under optimal and suboptimal conditions and evidence of bias was evaluated by mixed linear modelling.

Results: There was no evidence of systematic bias in any 3D-STE derived LV dyssynchrony indices (Table 1). Reliability ranged between poor and fair to good when good and sub-optimal quality images were analysed together (Table 1). Reproducibility was improved for most indices when restricting the analysis to good quality images (Table 1), nevertheless only volume, circumferential strain (CS) and principal tangential strain (PTS) derived indices achieved fair to good reliability, whereas longitudinal and radial-based indices remained poor. CS and PTS-based SDIs correlated well with volume-based SDI (r=0.70, p<0.0001 for PTS-SDI; and r=0.66, p<0.0001 for CS-SDI).

Conclusions: Sub-optimal image quality strongly compromised the reliability of 3D-STE derived LV dyssynchrony indices, but did not introduce systematic bias. Even with good quality images only indices based on CS, PTS or volume showed acceptable reliability.
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<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean (95% Confidence Interval)</th>
<th>Bias</th>
<th>Combined</th>
<th>Good</th>
<th>Sub-optimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI %</td>
<td>5.4 (4.0, 5.8)</td>
<td>0.4 (0.0, 0.8)</td>
<td>0.38</td>
<td>0.68</td>
<td>0.19</td>
</tr>
<tr>
<td>CS SDI %</td>
<td>5.3 (4.7, 5.9)</td>
<td>-0.0 (0.5, 0.4)</td>
<td>0.52</td>
<td>0.73</td>
<td>0.35</td>
</tr>
<tr>
<td>LS SDI %</td>
<td>2.0 (1.6, 2.4)</td>
<td>-0.2 (-0.6, 0.3)</td>
<td>0.10</td>
<td>0.39</td>
<td>0.42</td>
</tr>
<tr>
<td>PTS SDI %</td>
<td>4.3 (3.5, 4.8)</td>
<td>0.6 (0.1, 1.1)</td>
<td>0.29</td>
<td>0.52</td>
<td>0.16</td>
</tr>
<tr>
<td>RS SDI %</td>
<td>3.9 (3.4, 4.3)</td>
<td>0.2 (-0.3, 0.6)</td>
<td>0.28</td>
<td>0.27</td>
<td>0.06</td>
</tr>
<tr>
<td>D1_volumen</td>
<td>16.3 (15.0, 17.6)</td>
<td>0.7 (-0.6, 1.9)</td>
<td>0.36</td>
<td>0.71</td>
<td>0.04</td>
</tr>
<tr>
<td>CS D1 %</td>
<td>17.5 (15.4, 19.6)</td>
<td>-1.0 (-2.6, 0.7)</td>
<td>0.51</td>
<td>0.69</td>
<td>0.23</td>
</tr>
<tr>
<td>LS D1 %</td>
<td>7.2 (6.0, 8.4)</td>
<td>-0.6 (-2.1, 0.9)</td>
<td>0.13</td>
<td>0.28</td>
<td>0.46</td>
</tr>
<tr>
<td>PTS D1 %</td>
<td>14.6 (13.1, 16.0)</td>
<td>1.3 (-0.0, 2.6)</td>
<td>0.41</td>
<td>0.59</td>
<td>0.24</td>
</tr>
<tr>
<td>RS D1 %</td>
<td>13.0 (11.7, 14.3)</td>
<td>0.2 (-1.2, 1.6)</td>
<td>0.21</td>
<td>0.15</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Data are means (95% confidence intervals), $P_{Bonf}$ are Bonferroni adjusted P values. Abbreviations: CS, circumferential strain; D1, dispersion (difference between minimum and maximum time to peak of measure over 16-LV segments normalized to cardiac cycle length); ICC, intra-class correlation coefficient; LS, longitudinal strain; PTS, principle tangential strain; RS, radial strain; SDI, systolic dyssynchrony index. ICC < 0.4 = poor reproducibility, 0.4 ≤ ICC < 0.75 = fair to good reproducibility, and ICC ≥ 0.75 = excellent reproducibility.