A reliable M-mode ultrasound protocol for the assessment of diaphragm motion

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\section*{Introduction}

- Diaphragm is the principal inspiratory muscle
- Different techniques have been used to assess diaphragm motion. Among them, M-mode ultrasound has gained particular interest since it is non-invasive and accessible.
- However it is operator-dependent and no objective acquisition protocol has been established.

\section*{Purpose} to establish a reliable method for the assessment of the diaphragmatic motion via the M-mode ultrasound.

\section*{Material and Methods}

- 51 healthy subjects
  - 41 subjects
    - 58±8.5 Kg
    - 165±6.6 cm
    - 213±3.3 Kg/cm²
  - 10 subjects
    - 75±11.6 Kg
    - 179±7.7 cm
    - 23±3.4 Kg/cm²
- The right diaphragmatic motion was measured by M-mode ultrasound imaging in three different transducer positions:

\section*{Results}

<table>
<thead>
<tr>
<th>Right Diaphragmatic Range of Motion Results</th>
<th>DBT</th>
<th>Transverse Vll Hepatic Seg.</th>
<th>Transverse Vll Hepatic Seg.</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude (mm) Before</td>
<td>55.3±13.4</td>
<td>52.3±15.2</td>
<td>52.5±15.1</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>63.8±13.2</td>
<td>54.9±15.7</td>
<td>61.1±15.2</td>
<td></td>
</tr>
<tr>
<td>Amplitude (mm) Apeana</td>
<td>50.3±8.1</td>
<td>48.7±8.96</td>
<td>50.5±9.0</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>53.8±9.17</td>
<td>50.5±10.2</td>
<td>52.9±9.9</td>
<td></td>
</tr>
<tr>
<td>Slope (%) Before</td>
<td>4.6±3.7</td>
<td>4.9±3.7</td>
<td>7.2±5.4</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>6.5±3.4</td>
<td>4.9±3.7</td>
<td>7.2±4.6</td>
<td></td>
</tr>
<tr>
<td>Slope (%) Apeana</td>
<td>50.5±9.0</td>
<td>6.5±11.43</td>
<td>7.9±5.8</td>
<td></td>
</tr>
</tbody>
</table>

- DBT and transducer positioning affect the measurement of the diaphragm (ANOVA, p<0.05).
- The measurements from the transverse axis with a more middle ROI reveal a strong correlation (R=0.52, p<0.05) with statistical differences (p<0.05).
- The diaphragmatic range of motion increased 8.4 mm after DBT with a shift in the line slope from 0.05 to 0.39 (after).

\section*{Conclusions}

- The assessment of the diaphragm via M mode ultrasound is substantially dependent on the positioning of the transducer.

[CLINICAL IMPLICATIONS] Transverse transducer positioning with the image line crossing the right portal vein at the Vll Hepatic Segment is the most reliable and consistent way to study diaphragm motion