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Diagnostic accuracy of lung ultrasound for identification of elevated left ventricular filling pressure

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Topic(s):
Echocardiography: Systolic and Diastolic Function

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Aims: B-lines, in lung ultrasound (LUS), could constitute an interesting tool for LVFP evaluation in clinical practice, but data regarding their association with invasive hemodynamics are lacking. The purpose of this study is to explore the diagnostic accuracy of B-lines to identify elevated left ventricular end-diastolic pressure (LVEDP).

Method: 81 adults (mean age 75 years old) with significant dyspnea (NYHA³2) were prospectively analyzed by LUS, with the same probe than transthoracic echocardiography (TTE), in four areas in each hemithorax (detailed method in figure 1) and complete TTE within four hours before a coronary angiography.

Results: 28 patients had elevated LVEDP. A clinical model, including age, dyspnea NYHA³3 and heart failure signs, had a C-index of 79% to identify elevated LVEDP. Total B-lines number was higher in the elevated LVEDP group (1.0vs17.0, p<0.0001) and significantly increased diagnostic accuracy (C-index increase=15.5%, p=0.004) and the best net reclassification index (NRI=142.0, 108.5-175.6, p=0.0001), compared to other classical TTE parameters, on top of the clinical model.

Conclusion: This study demonstrates the important diagnostic capacity of B-lines to identify elevated LVEDP, which appears superior to the one of classical echocardiographic strategies. This tool should be considered in a multi-parametric approach of patients with heart failure.

<table>
<thead>
<tr>
<th></th>
<th>LVEDP&lt;20mmHg (n=53)</th>
<th>LVEDP&gt;20mmHg (n=28)</th>
<th>p-value</th>
<th>NRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral E/Ea average of annuli</td>
<td>11.6 (8.6-15.9)</td>
<td>15.6 (11.4-22.0)</td>
<td>0.014</td>
<td>17.8</td>
</tr>
<tr>
<td>Left Atrial Volume index (ml/m²)</td>
<td>45.7 (33.3-62.3)</td>
<td>49.1(36.4-62.6)</td>
<td>0.51</td>
<td>-2.7</td>
</tr>
<tr>
<td>Peak of tricuspid regurgitation velocity (m/s)</td>
<td>2.5+/-.4</td>
<td>2.9+/-.6</td>
<td>0.002</td>
<td>102.0</td>
</tr>
<tr>
<td>Inferior vena cava diameter (mm)</td>
<td>11.0(7.0-15.0)</td>
<td>18.5(15.0-20.0)</td>
<td>&lt;0.0001</td>
<td>119.9</td>
</tr>
<tr>
<td>Total B lines</td>
<td>1.0(0.0-4.0)</td>
<td>17.0(9.0-24.0)</td>
<td>&lt;0.0001</td>
<td>142.0</td>
</tr>
<tr>
<td>&gt;= 3 B lines</td>
<td>18(34%)</td>
<td>24(85.7%)</td>
<td>&lt;0.0001</td>
<td>103.5</td>
</tr>
<tr>
<td>&gt;= 8 B lines</td>
<td>5(9.4%)</td>
<td>22(78.6%)</td>
<td>&lt;0.0001</td>
<td>138.3</td>
</tr>
<tr>
<td>1 positive zone in each side</td>
<td>1(1.9%)</td>
<td>15(53.6%)</td>
<td>&lt;0.0001</td>
<td>110.5</td>
</tr>
<tr>
<td>2 positive zones in each side</td>
<td>0(0.0%)</td>
<td>10(35.7%)</td>
<td>&lt;0.0001</td>
<td>71.0</td>
</tr>
</tbody>
</table>

LVEDP: Left ventricular end-diastolic pressure; NRI: net reclassification index
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LVEDP<20mmHg (n=53)
LVEDP>20mmHg (n=28)
p-value NRI
Mitral E/Ea average of annuli 11.6 (8.6-15.9) 15.6 (11.4-22.0) 0.014 17.8
Left Atrial Volume index (ml/m²) 45.7 (33.3-62.3) 49.1 (36.4-62.6) 0.51 -2.7
Peak of tricuspid regurgitation velocity (m/s) 2.5+/−0.4 2.9+/−0.6 0.002 102.0
Inferior vena cava diameter (mm) 11.0 (7.0-15.0) 18.5 (15.0-20.0) <0.0001 119.9
Total B-lines 1.0 (0.0-4.0) 17.0 (9.0-24.0) <0.0001 142.0
>= 3 B-lines 18 (34%) 24 (85.7%) <0.0001 103.5
>= 8 B-lines 5 (9.4%) 22 (78.6%) <0.0001 138.3
1 positive zone in each side 1 (1.9%) 15 (53.6%) <0.0001 110.5
2 positive zones in each side 0 (0.0%) 10 (35.7%) <0.0001 71.0

LVEDP: Left ventricular end-diastolic pressure; NRI: net reclassification index

Panel 1: The four explored areas on the right hemithorax; Panel 2: Example of a freeze-e loop of lung ultrasound with B-lines; Panel 3: The different cut-offs analysed. A: one bilateral positive zone (defined by ≥ 3 B-lines in the same zone); B: two bilateral positive zones; C: simplified B-lines count: sum of all B-lines in the eight zones using two different cut-offs ≥3 or ≥8 B-lines.