Central Pressure and Pulse Wave Amplification in the Upper Limb

To the Editor:
The important review of pulse pressure (PP) amplification was directed at better understanding of central (ascending aortic or carotid) pressure generated from upper limb measurements of cuff arterial pressure and pressure waveforms. One important issue, not addressed by the authors, is how 2 different noninvasive techniques, widely used in current literature, can give different values of amplification and, thus, different values of central pressure from the same data recorded in the upper limb.

In the accompanying Table, compiled from articles quoted in the review, plus several others, invasive data give average values of 38% amplification and an average difference in systolic pressure (SP) of 14.5 mm Hg. The noninvasive generalized transfer function method showed similar values. The late systolic shoulder method provides values similar to the generalized transfer function method but has been applied less frequently. In contrast, central SP and PP calculated by extrapolation from mean and diastolic brachial values showed far smaller values of amplification, and average SP difference was just 1 mm Hg. Central SP and PP were virtually identical to brachial pressure! To our knowledge, this method has not been compared against invasively recorded central and peripheral waveforms and has not gained US Food and Drug Administration approval. It appears to be flawed.

Table. Comparison of Published Pressure Amplification Values

<table>
<thead>
<tr>
<th>Method</th>
<th>Invasive</th>
<th>Generalized Transfer</th>
<th>Brachial Tonometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude = arm PP/central PP (%)</td>
<td>31, 46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>53, 28, 45, 32&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-1, -1, -2, 0&lt;sup&gt;18&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>34&lt;sup&gt;c&lt;/sup&gt;</td>
<td>27, 27&lt;sup&gt;5&lt;/sup&gt;</td>
<td>1, 6, -2, 3&lt;sup&gt;19&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>36, 45&lt;sup&gt;2&lt;/sup&gt;</td>
<td>28&lt;sup&gt;10&lt;/sup&gt;</td>
<td>10, 0&lt;sup&gt;20&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>21, 31&lt;sup&gt;11&lt;/sup&gt;</td>
<td>-1, 0&lt;sup&gt;21&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>25&lt;sup&gt;12&lt;/sup&gt;</td>
<td>-1, 2&lt;sup&gt;22&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>22&lt;sup&gt;13&lt;/sup&gt;</td>
<td>0, 2&lt;sup&gt;23&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>44, 30, 32, 54, 30, 28&lt;sup&gt;14&lt;/sup&gt;</td>
<td>2, 4&lt;sup&gt;24&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>29, 36&lt;sup&gt;15&lt;/sup&gt;</td>
<td>2, 1, 0, -2, 15, 6, 6, 4&lt;sup&gt;4&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>26&lt;sup&gt;16&lt;/sup&gt;</td>
<td>23, 14, 6&lt;sup&gt;25&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>38</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>Amplitude = arm SP-central SP (mm Hg)</td>
<td>14&lt;sup&gt;1&lt;/sup&gt;</td>
<td>14, 11, 14, 10&lt;sup&gt;6&lt;/sup&gt;</td>
<td>-1, -1, -2, 0&lt;sup&gt;18&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>12&lt;sup&gt;7&lt;/sup&gt;</td>
<td>8.1, 10&lt;sup&gt;3&lt;/sup&gt;</td>
<td>0.3, -2, 1&lt;sup&gt;19&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>15.7, 16.3&lt;sup&gt;9&lt;/sup&gt;</td>
<td>11.6, 8.5&lt;sup&gt;17&lt;/sup&gt;</td>
<td>3, 2&lt;sup&gt;9&lt;/sup&gt;</td>
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<td></td>
<td>17&lt;sup&gt;10&lt;/sup&gt;</td>
<td>-1, -1&lt;sup&gt;21&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>8.4, 12&lt;sup&gt;11&lt;/sup&gt;</td>
<td>-2, 0&lt;sup&gt;22&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>8.8&lt;sup&gt;12&lt;/sup&gt;</td>
<td>0.8, 0.1, -1&lt;sup&gt;11&lt;/sup&gt;</td>
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<td>12, 12, 10, 14, 13, 12&lt;sup&gt;14&lt;/sup&gt;</td>
<td>8.4, 5.2, 2.4&lt;sup&gt;25&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>10, 8&lt;sup&gt;15&lt;/sup&gt;</td>
<td>0.3, -3, 4&lt;sup&gt;26&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>14.5</td>
<td>10.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Values of amplification of PP and SP are shown between arm (brachial or radial artery) and central sites (ascending aorta or carotid artery), as published for directly recorded pressure, using catheter systems or tonometry of adequate frequency response (column 1) and 2 different noninvasive methods. The generalized transfer method values are shown in column 2. The third column shows values determined from carotid pressure calibrated from brachial cuff and brachial tonometry through extrapolation to SP from mean and PP.

Disclosures
M.F.O. is the founding director of AtCor Medical, Sydney, Australia, maker of a pulse-wave analysis system.

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