Blood-flow pulsatility variation along the carotid artery including crossing the extracranial-intracranial border

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Background and purpose:
• Previous studies 1,2 reported attenuation of arterial flow pulsation over the carotid siphon part of the internal carotid artery (ICA).
• We aimed to confirm these results and further extend them by assessing the extracranial part of the ICA and by assessing the carotid distensibility by measuring the lumen Area Index (AI).
• The influence of age and sex on pulsatility and diameter distensibility, and the damping factor were also investigated.

Material and methods:
• Blood-flow pulsation was assessed using 2D PC-MRI at 3T (Philips) in 68 healthy volunteers.
• Pulsatility Index (PI) and AI were calculated from blood-flow velocities and number of voxels measured at the extracranial C1, carotid canal C4, and intracranial C7 segments of the ICA as defined by Bouthillier 3.
• The damping factor ([PI at C4]/[PI at C7]) was calculated to illustrate the effect of age and sex on damping across the carotid siphon.

Results:
• Reduction of PI measured between the C4 and C7 was significant (8.3%, P=7.2*10^-7) but between extracranial C1- and intracranial C7 was small and not significant (1.8%, P=0.14).
• The distensibility significantly decreased from C1 to C4, and significantly increased from C4 to C7.
• The reported PI and AI trend per vessel over the C1, C4, and C7 segments was consistently seen in 95% of the evaluated vessels.
• Damping over the carotid siphon significantly (P=2.1*10^-5) decreases with increasing age similarly for both sexes.

Interpretations:
• The addition of extracranial measurements and distensibility measurements suggest a more complicated behavior than just damping caused by the carotid siphon.
• The bony carotid canal seems to locally limit the distensibility of the ICA, thus increasing the flow pulsatility at C4.

Table 1: PI and AI for both male and female values: mean ± SD.

<table>
<thead>
<tr>
<th>ROI</th>
<th>Vessel</th>
<th>Gender (M/F)</th>
<th>PI</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Right ICA</td>
<td>M</td>
<td>0.97 ± 0.09</td>
<td>0.18 ± 0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>0.83 ± 0.10</td>
<td>0.18 ± 0.06</td>
</tr>
<tr>
<td>C4</td>
<td>Right ICA</td>
<td>M</td>
<td>1.04 ± 0.08</td>
<td>0.11 ± 0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>0.90 ± 0.11</td>
<td>0.12 ± 0.03</td>
</tr>
<tr>
<td>C7</td>
<td>Right ICA</td>
<td>M</td>
<td>0.94 ± 0.10</td>
<td>0.30 ± 0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>0.82 ± 0.12</td>
<td>0.29 ± 0.07</td>
</tr>
<tr>
<td>C1</td>
<td>Left ICA</td>
<td>M</td>
<td>0.99 ± 0.13</td>
<td>0.17 ± 0.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>0.82 ± 0.10</td>
<td>0.17 ± 0.04</td>
</tr>
<tr>
<td>C4</td>
<td>Left ICA</td>
<td>M</td>
<td>1.07 ± 0.18</td>
<td>0.12 ± 0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>0.89 ± 0.08</td>
<td>0.10 ± 0.03</td>
</tr>
<tr>
<td>C7</td>
<td>Left ICA</td>
<td>M</td>
<td>0.98 ± 0.16</td>
<td>0.29 ± 0.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>0.80 ± 0.11</td>
<td>0.29 ± 0.06</td>
</tr>
</tbody>
</table>

Conclusions:
• The PI patterns confirmed previous studies: PI significantly reduces over the carotid siphon between C4 and C7 location. PI reduction from extra- to intracranial (C1-C7) is not significant.
• Men have a significantly higher PI compared to women for all three ICA locations.

Interpretations:
• The addition of extracranial measurements and distensibility measurements suggest a more complicated behavior than just damping caused by the carotid siphon.
• The bony carotid canal seems to locally limit the distensibility of the ICA, thus increasing the flow pulsatility at C4.

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