Reproducibility of Secondary Vessel Segmentation on Magnetic Resonance Venography

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Background

- Magnetic resonance venography (MRV) is a non-invasive tool for imaging the vasculature, however, obtaining absolute cross-sectional area (CSA) measurements remain technically challenging. Previous study has shown that patients with multiple sclerosis (MS) have been shown to display higher numbers of secondary vessels in the neck, while simultaneously displaying a lower cross-sectional area (CSA) of the main arterial vasculature when compared to healthy controls (HC).

Multiple Sclerosis

- Multiple sclerosis is a chronic autoimmune-mediated demyelinating disease of the central nervous system (CNS). Demyelination of neuronal axons in the CNS reduces propagation of action potentials. This can result in a wide variety of symptoms from numbness in the extremities to a loss of visual acuity (optic neuritis).

Objective

- To assess and validate the intra- and inter-rater accuracy of MRV-derived vessel CSA quantification.

Materials and Methods

- The reproducibility examination was performed on subset of 10 HCs which were part of a larger cardiovascular, environmental, and genetic effects in MS (CEG-MS) study.
- In addition to the conventional images, the 3T MRI protocol also included MRV of the neck.
- The secondary vessels of predetermined MRV slices at each cervical level (C1/C2, C2/C3, C4, C4/C5, C5/C6, C6/C7, and C7/T1) were segmented by two trained operators using the Java Image Manipulator (JIM) software.
- All vessels except the internal jugular, common carotid, and vertebral artery were classified as secondary vessels.
- Intra- and inter-rater intraclass correlation coefficients (ICC) with a 95% confidence interval (CI) were calculated.

Results

<table>
<thead>
<tr>
<th>Collateral Vessel Level</th>
<th>Intrarater ICC (95% CI)</th>
<th>P value</th>
<th>Interrater ICC (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1/C2</td>
<td>.843 (.509-.984)</td>
<td>0.05</td>
<td>.971 (.719-.997)</td>
<td>0.002</td>
</tr>
<tr>
<td>C2/C3</td>
<td>.888 (.797-.988)</td>
<td>0.029</td>
<td>.998 (.982-1.00)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>C4</td>
<td>.924 (.497-.984)</td>
<td>0.014</td>
<td>.844 (.734-.997)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>C4/C5</td>
<td>.909 (.125-.991)</td>
<td>0.02</td>
<td>.979 (.802-.998)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>C5/C6</td>
<td>.882 (.130-.988)</td>
<td>0.013</td>
<td>.988 (.838-.999)</td>
<td>0.123</td>
</tr>
<tr>
<td>C6/C7</td>
<td>.972 (.734-.997)</td>
<td>0.002</td>
<td>.992 (.926-.999)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>C7/T1</td>
<td>.920 (.228-.992)</td>
<td>0.016</td>
<td>.967 (.680-.997)</td>
<td>0.003</td>
</tr>
<tr>
<td>Average</td>
<td>.935 (.872-.967)</td>
<td>&lt;0.001</td>
<td>.972 (.944-.986)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Legend: ICC = intraclass correlation coefficient, data is presented with a 95% confidence interval (CI). Data for intrarater and interrater ICC were obtained from 10 scans, 5 for each data set.

An average intra-class ICC for all segmented slices was 0.935 (0.872-0.967), p<0.001. The highest intra-class ICC was measured at the C6/C7 level 0.972 (0.734-0.997), p=0.002 and the lowest ICC was measured at the C1/C2 level 0.843 (.509-0.984) p=0.050. Similarly, the inter-class ICC for all segmented slices was 0.972 (0.944-0.986)p=0.001. The highest inter-class ICC was measured at the C2/C3 level 0.988 (.982-1.00), p<.001 and the lowest ICC was measured at C4 0.884 (.497-0.984) p=0.050.

Conclusion

- The ICC analysis showed highly reliable intra- and inter-class results. Previous anatomical knowledge, software training, and familiarization with image contrast are warranted for ensuring reliable and accurate MRV-derived vessel segmentation.

References