Non-Invasive Qualitative Evaluation of Intracranial Pressure in Chiari Malformation Patients – Pilot Project

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Disclosures

• The authors have no disclosures
Introduction

Chiari malformation (CM) is characterized by the shortness of the posterior fossa that leads to a tonsillar invagination through the foramen magnum in most of the cases. A difference in the CSF flow through the foramen magnum between systole and diastole are triggers for brain compliance changes and development of symptoms.

Clinical treatment is not effective in symptomatic CM and posterior fossa decompression is the treatment of choice. A correlation of re-establishment of brain compliance and CSF flow in foramen magnum is probably the key for improvement of the symptoms.

Brain compliance, however, is difficult to be measured in ambulatory patients, since there was lack of methods to do it. Mascarenhas et al. developed a method to qualitatively evaluate intracranial pressure (ICP) with a non-invasive (NI)(Brain4Care®) device attached externally to the skull able to delineate ICP curves. Effects of surgery on curves, brain compliance and correlation of these curves and symptoms can be evaluated.
Methods

A prospective cohort study with CM patients in the waiting list for posterior fossa decompression (PFD) at Clinics Hospital of University of São Paulo.

Measurements of NI ICP, neurological and general symptoms and signals were collected in 6 patients pre and 1 month after posterior fossa decompression with a standard technique: 3x3 cm posterior craniectomy and excision of the posterior arch of C1, with opening of the dura, arachnoid excision and galea duroplasty. When the tonsillar invagination was under the posterior arch of C2, tonsillar coagulation was performed and Magendie foramen visualized to assure re-establishment of CSF flow in cranio-cervical junction.

Measurement of NI ICP (Brain4Care®) was done with an external strain-gauge device, attached to the skull by a strip, able to show morphological patterns of the intracranial pressure curves and calculate the magnitude of P1, P2 and P3 during 10 min in supine position. One minute was represented by a curve and a mean of P1 and P2 in all periods was done.

Relationship P2/P1 was calculated in two moments and pared t test with Software STATA 12.0 was used for sample size (SZ) calculation (80% power, p<0.05, missing data of 20%) for future prospective, observational study.
Results

The mean of P2/P1 in the pre-operative patients was 1.33 and 1.02 in post-operative patients, showing an improvement tendency.

Based on these results, we calculated the ideal sample size for a prospective controlled trial, with a two-sided p<0.05 and a power of 80% for statistical significance.

The ideal sample size for this trial is 23 patients.

Considering an acceptable missing data as 20%, the ideal sample size for the main trial increased to 28 patients.
### Results

Table 1. Main Symptoms, Post-operative Gestalt evaluation and P2/P1 values in pre and pos posterior fossa decompression.

<table>
<thead>
<tr>
<th></th>
<th>Sex</th>
<th>Main Symptoms</th>
<th>PO Symptoms</th>
<th>Pre</th>
<th>P2/P1</th>
<th>PO P2/P1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt 1</td>
<td>M</td>
<td>Typical Headache/ Ataxia/ Myelopathy/ Hypoesthesia/ Cranial Nerve</td>
<td>Impaired myelopathy/ improved ataxia/ headache</td>
<td>1,618</td>
<td>1,251</td>
<td></td>
</tr>
<tr>
<td>Pt 2</td>
<td>F</td>
<td>Typical Headache/ Myelopathy/Ataxia/ Cranial nerve/ Hypoestesia</td>
<td>Improved</td>
<td>1,094</td>
<td>0,862</td>
<td></td>
</tr>
<tr>
<td>Pt 3</td>
<td>F</td>
<td>Typical Headache/ Ataxia</td>
<td>PO meningites/ Worse</td>
<td>0,88</td>
<td>0,891</td>
<td></td>
</tr>
<tr>
<td>Pt 4</td>
<td>M</td>
<td>Myelopathy/ Hypoesthesia/ Cranial Nerve /Ataxia</td>
<td>Improved except hypoesthesia</td>
<td>1,063</td>
<td>0,795</td>
<td></td>
</tr>
<tr>
<td>Pt 5</td>
<td>F</td>
<td>Typical Headache/ Hypoesthesia/ Ataxia/ Cranial nerve</td>
<td>Improved</td>
<td>1,163</td>
<td>1,321</td>
<td></td>
</tr>
<tr>
<td>Pt 6</td>
<td>M</td>
<td>Typical Headache/ Myelopathy/ Ataxia</td>
<td>Improved / keep ataxia</td>
<td>2,22</td>
<td>1,01</td>
<td></td>
</tr>
</tbody>
</table>
Results

When we observe the correlation of the improvement in symptoms and P2/P1, we can conclude that most of the patients that improved showed lower P2/P1 values post-op. Patient 3 did not improve the curve morphology probability because had meningitis and the correlation remained almost the same. Patient 5 had a clinical good outcome, however did not improve the P2/P1.

Morphological representation of ICP 1 minute curve in patient 1 pre-operative (left) and post-operative (right), showing a clear improvement in P2/P1.
Discussion

Decrease in brain compliance is the main pathophysiological issue related to development of the symptoms in Chiari type 1 disease. Re-establishment of CSF flow at cranio-cervical junction is the objective of PFD. Non-invasive evaluation of brain compliance and intracranial pressure has been possible through pulse pressure gradient at cranio-cervical junction in phase-contrast MRI and that could be a way to predict development of the symptoms and evaluate re-establishment of CSF flow after PFD. However, a less invasive, ambulatory and cheaper method has not yet being tested to measure ICP in CM patients.

Possible reasons for not improving P2/P1 in patient 5 could be related to a chronic compression and symptomatology (10 years) and concomitant basilar invagination with severe siringomielia. In this patients we could have chronic impairment of brain compliance.

This pilot study shows that non-invasive ICP device can show brain compliance during CM treatment and be used to follow-up ambulatory patients, predicting the surgical success. ICP in other diseases could be possible accurately measured in the future allowing a better understanding of their natural history.
Summary Points

• Brain compliance and CSF flow at cranio-cervical junction are the most important parameters on complementary evaluation of CM patients

• NI ICP (Brain4Care®) monitoring allowed new correlation of the ICP morphology and patient symptomatology in post-operative of PFD

• Sample Size calculation for a large prospective cohort was calculated in this pilot project