Assessing Volumetric Changes in the Cervicomedullary Junction Following Posterior Fossa Decompression in Adult Chiari Patients

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BACKGROUND

Chiari malformation type 1 (CM1) is a disorder of the cervicomedullary junction that affects between 300,000 to 500,000 individuals annually 1. CM 1 is defined by the idiosyncratic downward displacement of the cerebellar tonsils less than 5 millimeters beyond the foramen magnum into the spinal column, as well as by the associated changes to typical cerebrospinal fluid (CSF) flow. CM 1 patients often experience neck pain, recurrent paroxysmal headaches, discoordination, muscle weakness and numbness, dysphasia, and tinnitus.

The majority of CM1 symptoms are typically complications of the compression of the cerebellum and brainstem as well as restricted CSF flow. Consequently, the main course of treatment is the enlargement of the posterior fossa and restoration of typical CSF flow, thus mitigating symptoms and impeding the progression of further pathophysiological changes to the brain; this is typically done through posterior fossa decompression 3,4.

OBJECTIVE

To assess volumetric changes in cervical spinal cord at the cervicomedullary junction following posterior fossa decompression in adult CM1 patients.

METHODS

A retrospective analysis of T2 weighted MR images of twelve adult patients who underwent initial posterior fossa decompression at the University of California, Los Angeles was conducted. The procedure was performed as follows:

- Ten millimeters cranial to the medullary beak to the caudal endplate of the second cervical vertebra was measured in preoperative and six months postoperative scans to define the area of interest (Figure 1)
- ITK-Snap (www.itksnap.org) was used to calculate the volumetric difference between the scans
- Manually calculated the percent change between pre- and post-operative scans
- Pre- and post-operative scans were compared using an unpaired students t-test. A p-value <0.05 was considered significant.

![PRE OPERATIVE SCAN](image1)

**Figure 2:** Typical Post-Operative Scan of Cervicomedullary Junction

![POST-OPERATIVE SCAN](image2)

**Figure 3:** Typical Post-Operative Scan of Cervicomedullary Junction

| Volumetric Change Between Pre- and Post- Operative Scans (mm³) |
|------------------|------------------|------------------|------------------|------------------|
| Patient 1        | 3700             | 3757             | 57              | 0.015            |
| Patient 2        | 2354             | 2479             | 125             | 0.053            |
| Patient 3        | 3308             | 3646             | 338             | 0.102            |
| Patient 4        | 2803             | 2879             | 76              | 0.027            |
| Patient 5        | 3021             | 3287             | 266             | 0.088            |
| Patient 6        | 3700             | 3932             | 232             | 0.063            |
| Patient 7        | 3775             | 4046             | 271             | 0.072            |
| Patient 8        | 3305             | 3318             | 13              | 0.004            |
| Patient 9        | 3284             | 3424             | 140             | 0.043            |
| Patient 10       | 4449             | 4672             | 223             | 0.050            |
| Patient 11       | 4225             | 4308             | 83              | 0.020            |
| Patient 12       | 2674             | 2710             | 36              | 0.013            |
| AVERAGE          | 3538.17          | 3538.17          | 155.00          | 0.05             |

![Volume (mm³)](image3)

**DISCUSSION**

Although multiple measurements have been developed to quantify the severity of CM1 and the extent of decompression, these assessments are limited in both their applicability and clinical significance. In this study, we explored the changes in the area of the craniocervical cord at the medullary beak before and after decompressive surgery in a cohort of twelve patients, finding the craniocervical cord surrounding the medullary beak to increase an average of 155 mm³ or 3.4%.

The area of the cord ten millimeters cranial to the medullary beak and down to the cervical-2 vertebrae is a simple, direct assessment of the craniocervical cord that can be used to assess the changes after intervention.

Although straightforward and clinically relevant measures were applied in this study, it was hindered by a few factors. Primarily, it was a small, retrospective analysis with twelve CM1 patients. Furthermore, the population was limited as several of the clinical quality MRI scans were too poor for analysis in our study. A prospective study with higher resolution MRI and more subjects will allow for a powerful, comprehensive anatomic analysis.

REFERENCES