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IMPORTANCE FOR CHIARI PATIENTS

This project will provide a more concise understanding of geometric differences between the cerebrospinal fluid (CSF) in Chiari patients before and after decompression surgery. After analyzing several patients CSF space differences coupled with pre and post operation symptoms, the relationships are expected to be consistent enough between patients such that a mathematical description can be developed. This correlation could help predict necessary operation techniques as well as surgical outcome.

ABSTRACT

To analyze the geometric differences, it was first necessary to align the 3D models of the cerebrospinal fluid space. After alignment, the area, perimeter, and hydraulic diameter for a single patient were measured along the spinal axis to compare pre and post decompression operation CSF. The correlation between geometric differences and patient symptoms can then be discovered.

INTRODUCTION

A consistent 3D geometric analysis tool and imaging of results are desired for analysis of multiple patients. The initial alignment will show overlapping 3D CSF space for visible inspection. Furthermore, the tool will illustrate the differences between the areas, perimeters, and hydraulic diameters of a patient's CSF along the spinal axis. Each patient's data will be related to their individual symptoms and then compared to the data of other patients.

METHODS

The analytical tool uses an iterative closest point algorithm minimizing the distances between numerous surface points of two CSF models. Depending on size, some models were truncated at locally similar geometries for better alignment. Geometric parameters were determined with cell grids overlapping the spinal cross-sections and compared relative to the location from the foramen magnum.

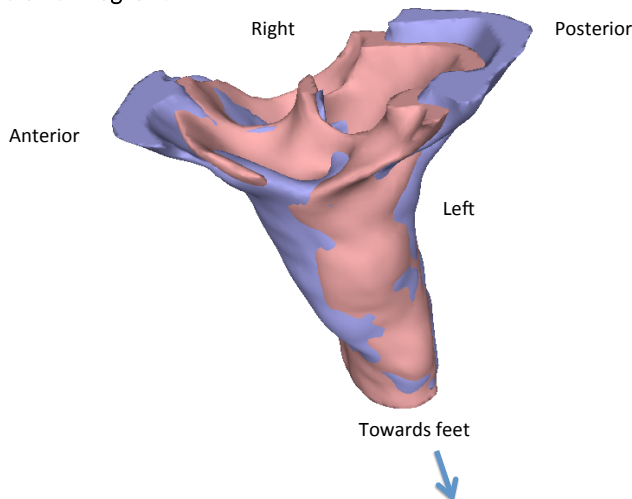


Figure 1. Alignment visualization between CSF space near the craniocervical junction for a Chiari patient pre (salmon) and post decompression surgery (violet).

CSF Geometric Parameters Measured Along the Spinal Axis

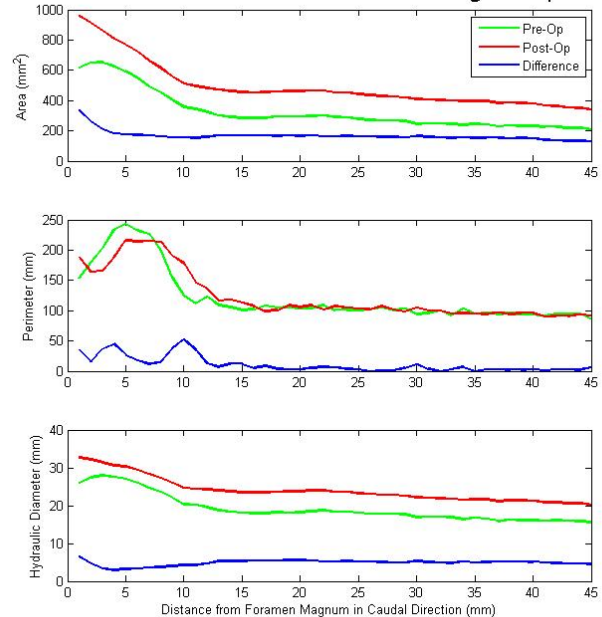


Figure 2. Illustration of a patient's pre-operation CSF, post-operation CSF, and CSF differences for area, perimeter, and hydraulic diameter.

RESULTS AND DISCUSSION

While the perimeters and hydraulic diameters display only slight differences between operations for this patient, the available CSF flow area shows a valuable increase. A larger database of patient pre-op geometries, post-op geometries and symptoms are necessary to discover consistent relationships. Continued use of the developed analytical tool with multiple patient data sets will uncover possible correlation between the geometric results shown above and Chiari patient characteristics.

Limitations

User reliability and consistency of the analytical tool is still to be determined.

CONCLUSIONS

- Analytical software is efficient in displaying geometric differences between different CSF models
- Alignment of geometries provides a satisfying visual interpretation of spatial differences for decompression surgery patients
- With additional data and analysis, expectations are high to develop a concise mathematical model to aid in Chiari malformation research