Key Points

1. Morphometrics involves using MRI data to measure skull features
2. Has led to the theory that Chiari is due to a lack of skull growth
3. However, not all studies have found this and results can vary based on the specific technique used
4. Study from India looked at the foramen magnum area of pediatric Chiari patients using two separate techniques
5. With both techniques, there was no difference found between the average foramen magnum area in Chiari children versus healthy controls
6. Also found a wide variety of foramen magnum shapes
7. Direct comparison of different measuring techniques is needed to establish best practices for morphometric research

Definitions

control group - in a study, a group of healthy subjects which are used as a basis of comparison

cranium - the skull

foramen magnum - opening in the base of the skull through which the brain and spine connect

hexagon - six sided shape

intracranial - inside the skull

morphometrics - in Chiari research, studying the size and shape of the skull

pentagon - five sided shape

posterior fossa -region in the back of the skull where the cerebellum is situated

tetragon - four sided shape

cerebellar tonsils - portion of the cerebellum located at the bottom, so named because of their shape

No Difference In Size Of Foramen Magnum Pediatric Chiari

September 30, 2009 -- Morphometrics, the study of the size and shape of the skull, has received a lot of attention in the Chiari community. In fact, it was measurements of the posterior fossa volume which led to the now widely accepted theory that Chiari often involves a lack of skull growth and a normal sized brain.

Despite the growing popularity of this theory, and of the use of morphometrics in general, these types of studies have not always produced consistent results. The reality is that different techniques can be used to measure specific features, such as posterior fossa size, and they do not always produce the same number. In addition, not all studies have found that Chiari patients have small posterior fossas, and pretty much no one claims that this finding is true for each and every Chiari person (as opposed to a group average). In fact, in private conversations with neurosurgeons and researchers, some question the overall value of looking at posterior fossa size at all.

Now, a study from India (Furtado et al) has found no difference in the size of the foramen magnum in children with Chiari versus age matched, healthy controls. The foramen magnum is the opening at the bottom of the skull through which the brain and spine connect. It is also the demarcation line for Chiari, meaning that if the cerebellar tonsils are located below the foramen magnum, they are considered to be out of position, or herniated. Previously, research studies have shown that, similar to the posterior fossa finding, at least some Chiari patients have wider foramen magnums than average.

The group from India looked at 21 pediatric Chiari patients, 15 girls and 6 boys, with a minimum herniation of 5mm. The average age of the group was 12 years. The average size of their herniations was a significant 11mm, and 15 of the group had syrinxes.

The researchers used two different techniques to measure the area of the foramen magnum. The first was an estimate derived from each person's measured total intracranial volume. The second technique used MRI software to measure the foramen magnum region. Interestingly, they found that there were no significant differences in the area of the foramen magnum in the Chiari group versus the healthy controls (Figure 1). Even though there were small differences between the values produced by the two different techniques, these were not statistically significant either. Finally, they found no real difference between children with syrinxes and children with Chiari only.

It seems apparent that morphometric research is in the early stages of development as far as Chiari is concerned given the variety of findings that have emerged. One challenge is likely the wide variation in skull shape and size that is found in the general population, making comparisons difficult. Some have tried to get around this problem by using ratios instead of outright values, but it is not clear if this works.

The Indian researchers highlighted the natural variety that exists among people by cataloging the shape of the foramen magnum in both the Chiari and control groups. Specifically, in both groups, they found shapes that included: oval, egg, round, tetragonal, pentagonal, hexagonal, and some that were too irregular to classify (Figure 2). Interestingly, the distribution of subjects along these foramen magnum shapes was actually fairly similar between the two groups.

Given the state of morphometric research, two interesting studies to undertake would be to compare the different techniques that have been used in published research to see what the variations are between them in looking at the same MRIs and also to look carefully at the natural variations that exist between people. Once these are established, how Chiari compares can be looked at with more confidence.

Table 1: Average Foramen Magnum Area (Estimated and Measured) For Chiari vs Control Group

	Chiari	Control
Estimated (cm2)	5.521	5.503
Measured (cm2)	6.059	5.872

Note: None of the differences were statistically significant

Table 2: Foramen Mangum Shapes, Chiari vs Control Group

cerebellum - part of the brain located at the bottom of the skull, near the opening to the spinal area; important for muscle control, movement, and balance

cerebrospinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

Chiari malformation I - condition where the cerebellar tonsils are displaced out of the skull area into the spinal area, causing compression of brain tissue and disruption of CSF flow

syringomyelia - condition where a fluid filled cyst forms in the spinal cord

Source

Posterior fossa morphometry in symptomatic pediatric and adult Chiari I malformation. Furtado SV, Reddy K, Hegde AS. J Clin Neurosci. 2009 Sep 5.

	Chiari	Control
Oval	3	4
Egg	2	3
Round	1	3
Tetragonal	4	3
Pentagonal	3	1
Hexagonal	4	5
Irregular	4	2

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