Key Points

1. Craniectomy, removing part of the skull, is a standard technique with Chiari decompression surgery
2. How much bone to remove remains an open question
3. Removing too little may not relieve symptoms, while removing too much can cause complications
4. Researchers measured the posterior fossa volume (PFV) of 11 Chiari patients before and after surgery
5. The same amount of bone was removed from each patient; the patients natural variations in skull size resulted in different amounts of increase in PFV
6. Percentage increase in PFV was significantly related to surgical outcome
7. 4 of 6 patients with >10% increase had complete recoveries; while all 5 with <10% only had partial recoveries
8. More research needed to precisely define what the optimal increase in PFV is

Definitions

cerebellar ptosis - serious complication of decompression surgery where the cerebellum slumps lower, resulting in a return of the herniation, often due to too much bone being removed during surgery

craniectomy - surgical technique where part of the cranium, or skull, is removed

duraplasty - surgical technique where a patch is sewn into the covering of the brain (the dura) in order to expand it

morphometric - in this context refers to anatomical measurements of the skull

occipital - having to do with the back of the head

Post-op Posterior Fossa Volume Increase Correlated w/ Outcome

March 31st, 2011 -- How much is enough? In terms of the size of a craniectomy - the part of decompression surgery where a piece of skull is removed - that is the question that a group of researchers from France (Noudel et al.) recently studied. Their results, published on-line in the Journal of Neurosurgery, presents strong evidence that the amount of increase in posterior fossa volume as a result of surgery is related to a patient's outcome and also indicates there may be a target which surgeons can strive for.

One of the main goals of Chiari decompression surgery is to create more room around the cerebellar tonsils in order to relieve pressure and restore the normal flow of cerebrospinal fluid. The area of the skull where the cerebellum sits, is referred to as the posterior fossa. Research has found that for at least a subset of patients, the Chiari herniation is actually due to an abnormally small posterior fossa (Note: Conquer Chiari is funding research to examine the developmental processes that underlie a small posterior fossa). By removing bone, Chiari surgery in effect expands the posterior fossa space.

While much attention recently has been focused on whether the dura should be opened as part of decompression surgery, how much bone to remove from the skull also remains an open issue. Removing too little may result in insufficient decompression and no relief from symptoms; removing too much can result in a very serious complication known as cerebellar ptosis, where the brain slumps down in the skull (because too much supporting bone was removed) resulting in worsening herniation.

The French researchers hypothesized that the amount that the posterior fossa is expanded as a result of surgery would be related to the success, or failure, of the surgery in relieving symptoms. To study this, they performed the same size craniectomy on 11 Chiari patients and used MRIs to measure the posterior fossa volume before and after surgery. The natural variation in skull size and shape among the patients would result in different percentage volume increases, and allow them to study the relationship of these volume increases with the outcome of the surgery.

The patient group was comprised of 6 men and 5 women with an average age of 35 years. Six of the group had syrinxes, but patients with additional bony abnormalities were excluded. On average, the patients had suffered for years with symptoms, with headache being the most common.

In order to assess improvement after surgery, the doctors used a functional grading scale with six grades (0 - V, Table 1). The scale incorporated both objective clinical findings and patient reported impact on work and daily living. While many techniques have been developed to measure posterior fossa volume prior to surgery, because bones in that area were removed as part of surgery, the researchers also developed their own technique to measure the PF volume post-surgically that would be consistent with the measurement technique used pre-surgically.

The surgery itself involved the same amount of bone removed as part of craniectomy for every patients, plus removal of part of C1. In addition, the dura was opened, but the arachnoid underneath was left intact and duraplasty was not performed. There were no surgical complications in the group. All patients underwent MRIs and clinical assessments several times after surgery and were followed for an average of 45 months.

Prior to surgery, 8 patients were rated as Grade 3 on their functional scale, 2 were Grade 4, and 1 was Grade 1 (Table 2). After surgery, 4 patients experienced a complete recovery (Grade 0), 4 had good improvement (decrease of 2 or more grades), and 3 had showed slight improvement (decrease of one grade) (Table 3).

The researchers found that surgical improvement was not statistically related to patient factors such as height, weight, tonsillar herniation, or individual morphometric measurements of the skull, but the did find that improvement was significantly related to the percentage of increase in the posterior fossa volume.

Specifically, the average PF volume prior to surgery was 174.8 cm3, which increased to an average of 192.1cm3 after surgery. This represents an average increase of 10.2%. Interestingly, 4 of the 6 patients whose PF volume increased by more than 10% had complete recoveries, while all 5 patients whose PF volume increased less than 10% only had partial recoveries. In addition, the average increase for the patients who had complete recoveries was 15%. Based on this result, the authors suggest that surgeons should tailor the amount of bone removed in each patient in an attempt to reach this level of increase in the posterior fossa volume.

While this finding does present a fairly strong case against a one size fits all approach to craniectomy, more, and expanded, research will be required to validate this type of calculation and also to further define the optimal increase in posterior fossa volume. One.htmlect of the debate not mentioned, was what effect opening the dura might have on this. In other words if the dura is opened, can less bone be removed and an optimal result still be

posterior fossa - depression on the inside of the back of the skull, near the base, where the cerebellum is normally situated

posterior fossa volume - volume of the posterior fossa region, usually calculated from MRI

Common Chiari Terms

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

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

decompression surgery - general term used for any of several surgical techniques employed to create more space around a Chiari malformation and to relieve compression

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

Source

Source: Posterior fossa volume increase after surgery for Chiari malformation Type I: a quantitative assessment using magnetic resonance imaging and correlations with the treatment response. Noudel R, Gomis P, Sotoares G, Bazin A, Pierot L, Pruvo JP, Bordet R, Roche PH. J Neurosurg. 2011 Feb 4.

achieved?

Perhaps we are not too far away from the day when surgeons, perhaps with the help of some sophisticated software, plan precisely for each patient how much bone to remove, where to remove it from, and whether to open the dura. If it were to happen, that would truly represent an advancement in Chiari care.

Table 1: Functional Grading System for Chiari Patients

Grade	Clinical Exam	Functional
0	normal	asymptomatic
I	normal	slight impairment
II	objective signs	slight impairment
III	objective signs	personal and professional disturbances
IV	disabled	persistence of autonomy
V	disabled	loss of autonomy

Table 2: Pre and Post Op Functional Grades (11 Patients)

Grade	# Preop	#Postop
0	0	4
I	1	3
II	0	3
III	8	1
IV	2	0

Table 3: Long Term Improvement (11 Patients)

Complete	4
Good	4
Slight	3

Complete = Asymptomatic
Good = Decrease of 2 or more grades
Slight = Decrease of 1 grade

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