

Background

Posterior fossa decompression (PFD)

surgery is the most accepted treatment for Chiari I malformation (CM-I), and typically involves craniectomy without replacement of bone. Bone replacement procedures may be seen as counter-intuitive when the goal of decompression is to increase posterior fossa volume (PFV). However, craniotomy is almost unanimously the typical procedure of choice in most other posterior fossa pathology requiring surgery.

Bone replacement could potentially restore bony structural support and provide an attachment for suboccipital muscles, reducing the risk of adhesions to the dura, recurrence, and postoperative headaches. Additionally, several studies show an association with wide craniectomy and cerebellar ptosis, a long-term complication of CM-I, and have used craniotomy or cranioplasty for treatment. (2-5)

We postulate that the concern to perform a craniotomy for CM-I is historical but misguided.

Objective

To compare **clinical and radiological outcomes** between craniotomy and craniectomy procedure for CM-I using a validated clinical outcome scale.

Methods

Patients aged 1-18 years who had undergone PFD for CM-I at Sydney Children's Hospital (2011-2016) were recruited. **Exclusion criteria:** other types of CMs, previous PFD, shunts, current malignancy.

Patients were classified into two groups depending on which decompressive procedure they had undergone:

Craniotomy OR Craniectomy

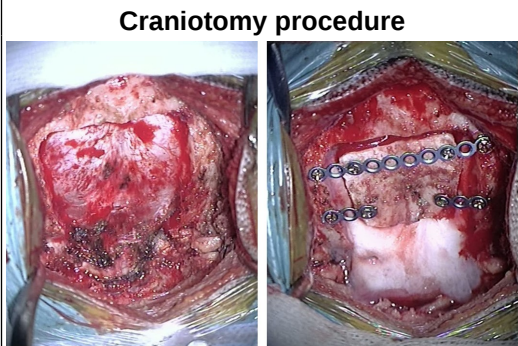


Figure 1. Left: Bony window removed (3cmx3cm), Right: Bone flap replaced with Leibinger plates and screws. Rostral ends completely apposed resulting in larger foramen magnum.

Outcome measures

Clinical outcomes: Medical records and questionnaire based on the **Chicago Chiari Outcome Scale (CCOS)** (1) were used to obtain data on symptom severity, functionality, surgical complications, operative time, and hospital stay.

Pain	Non-pain	Functionality	Complications	Total Score
1: Worst	1: Worst	1: Unable to attend	1: Persistent complication, poorly controlled	4: Incapacitated outcome
2: Unchanged and refractory to medication	2: Unchanged and refractory to medication	2: Moderate impairment (<50% attendance)	2: Persistent complication, well controlled	8: Impaired outcome
3: Improved or controlled with medication	3: Improved or controlled with medication	3: Mild impairment (>50% attendance)	3: Transient complication	12: Functional outcome
4: Resolved	4: Resolved	4: Fully functional	4: Uncomplicated course	16: Excellent outcome

Figure 2. CCOS adapted from Aliaga et al. (2012) (1)

Radiological outcomes:

Pre/postoperative MRI scans were used to measure:

1. Posterior fossa volume (PFV)
2. Posterior Fossa ratio (PFVR):
Postoperative PFV/Preoperative PFV
3. Original syring size and reduction postoperatively (diameter, length)

Results

Total 31 patients recruited: 7 had undergone the index craniotomy procedure, 24 the conventional craniectomy. There was no significant difference in baseline demographics between the groups.

Variable	Craniotomy (n=7)	Craniectomy (n=24)	p value*
Male: female	4:3 (57:43)	12:12 (50:50)	.539
Age at time of surgery, yrs	8.3 ± 5.5 [1.25-15]	8.6 ± 4.9 [1-17]	.905
Surgical Technique			
Laminectomy, C1-C2	6:1 (86:14)	19:5 (79:21)	1.00
Duraplasty	7 (100)	20 (83.3)	.550
Dural Graft Material			.546
Tonsillectomy/shrinkage	7 (100)	18 (75)	.293
Symptom Duration			.087
Mean follow-up time, months	27.6 ± 8.3 [18-41]	29.3 ± 14.3 [4-52]	.772
Patients with syrinx	4 (57.1)	6 (25.0)	.172

Data are represented as number (percentage), mean ± SD or mean ± SD [range]. *p value was calculated using T-test, Mann-Whitney U test, Pearson's Chi Square test and Fischer's Exact Test where appropriate..

Clinical Outcomes

There was **no statistically significant difference** in clinical outcomes between the groups. However, a higher incidence of postoperative headaches (25% vs. 0) and one case of cerebellar ptosis in the craniectomy group was observed.

	Craniotomy (n=7)	Craniectomy (n=24)	p value*
Overall CCOS ^a score	14.0 ± 2.5	13.9 ± 1.6	.872
Pain Symptoms	3.4 ± .79	3.3 ± .81	.729
Non-pain symptoms	3.1 ± .90	3.1 ± .78	.872
Function	3.9 ± .38	3.8 ± .51	.908
Complications	3.6 ± .79	3.7 ± .55	.835
Operative time, hrs	165.3 ± 37.7	152.9 ± 45.9	.521
Hospital stay, days	5.4 ± 1.3	5.71 ± 2.0	.945
Postoperative headaches	0	6 (25)	.161
Neck stiffness/pain	1 (14)	7 (29)	.642

Data are represented as number (percentage) or mean ± SD. *p value was calculated using T-test, Mann-Whitney U test where appropriate. ^aCCOS: Chicago Chiari Outcome Scale score out of 16, score out of 4.

Radiological Outcomes

Only **18 scans** were available for review:
5 craniotomy, 13 craniectomy.

	Craniotomy (n=7)	Craniotomy (n=24)
No. scans available	5 (71)	13 (54)
Tonsillar descent, mm	16.3 ± 6.5	16.7 ± 6.0
Pre-op PFV ¹ , mm ³	163.1 ± 9.5	165.8 ± 18.6
Time since scan, months	11 ± 2.8	13.2 ± 9.3
PFVR ¹	1.07 ± .075	1.06 ± .037
Syrinx		
Number of syrxinx patients	4 (57)	6 (25)
No. scans available	3/4 (75)	4/6 (80)
Syrinx diameter, mm	6.8 ± 1.2	7.4 ± 2.8
Syrinx length, mm	6.3 ± 5.8	6.0 ± 6.9
Reduction in syrxinx diameter, mm	5.8 ± .82	2.6 ± 1.9
Reduction in syrxinx length, mm	5.0 ± 5.3	3.8 ± .48

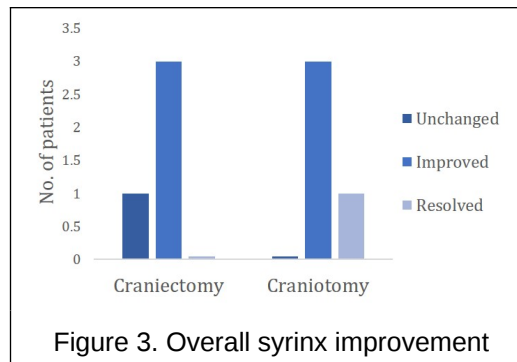
Data are represented as number (percentage) or mean ± SD. ¹PFV: Posterior Fossa Volume, ¹PFVR: Posterior Fossa Volume Ratio = Post-surgery PFV/Preoperative PFV.

Table 3. Radiological outcomes

Radiological outcomes were similar between the groups. Craniotomy achieved comparable rate of increase in PFV to craniectomy (1.07 vs.1.06).

Syrinx

Overall, syrinx improvement/resolution was achieved in most patients (Figure 3). There was a greater reduction of syrinx diameter and length in the craniotomy group (Table 3).



Conclusion

- Overall craniotomy has **comparable clinical and radiological outcomes** to conventional craniotomy.
- Bone replacement has potential to provide structural support to prevent long-term complications such as cerebellar ptosis and postoperative headaches - our study found a higher incidence of complications in the craniectomy group.
- Future studies are required to determine if craniotomy can prevent these complications.

References

1. Aliaga L et al. Neurosurgery 70:656-64; discussion 64-52012.
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