

“Stealth cranioplasty:” A novel endeavor for symptomatic adult Chiari I patients with syringomyelia: Technical note, appraisal, and philosophical considerations

ABSTRACT

Aim and Objective: In this article, we describe a novel technique of reconstruction of posterior fossa by cranioplasty with use of preshaped titanium mesh following posterior fossa decompression (PFD) for Chiari malformation type I (CMI) with syringomyelia (SM) in symptomatic adults.

Materials and Methods: Eleven patients underwent limited PFD and expansive cranioplasty with preshaped titanium mesh, what we term as “Stealth Cranioplasty” (SCP), following arachnoid preserving duraplasty (APD) and hexagonal tenting of the duraplasty with the cranioplasty (HTDC) for the management of symptomatic adult CMI with SM. All these patients had syringes extending from 3 to >10 vertebral levels.

Results: Seven male and four female symptomatic CMI adult patients, between age ranges of 22 and 44 years (mean 29.45 years), presented with different neurological symptoms related to CMI and SM for 6–84 months (mean 37.09 months). All the patients underwent PFD, APD followed by SCP and HTDC and were followed up for 7–54 months (mean 35.90 months). Of 11 patients, 8 patients improved according to the Chicago Chiari Outcome Scale (CCOS) with score of 13–15 while 3 patients remained unchanged with CCOS of 12, and there was no worsening. There was no complication related to Chiari surgery in any of the patients. All the patients had good reestablishment of cisterna magna. Two patients had marked reduction of syrinx while eight patients had moderate-to-mild reduction and one patient had no change of syrinx. None of the patients needed redo surgery.

Conclusion: SCP is an effective, fruitful, and cost-effective technique for the management of symptomatic adult CMI with SM. This technique has the advantages of preventing complications and recurrences in addition to the improvement of symptoms by addressing the basic pathology.

Keywords: Arachnoid preserving duraplasty, Chiari malformation type I, hexagonal tenting of the duraplasty with the cranioplasty, stealth cranioplasty, syringomyelia

INTRODUCTION

Chiari malformation (CM) and its management are a long debated enigma for neurosurgeons. Many neurosurgeons have innovated and practised many surgical procedures for this baffling and formidable entity to give the patients a happy life. The results of the commonly practiced surgical procedures are still not always very gratifying in a good number of patients.

Most of the surgical procedures in practice today are based on the most popular and recognized basic pathophysiology of CM, the overcrowded shallow posterior fossa causing

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herniation of the contents through the foramen magnum, giving rise to various clinical manifestations. We also believe in this and our innovation revolves around this well-established theory.

It appears that all the procedures that are in practice today are targeted to address one or more of the things that cause symptoms. The initial improvements in clinical symptoms a patient enjoys immediately after surgery, often does not persist for long. In many cases, endeavors in the planning of surgery to prevent recurrence along with alleviation of symptoms are trivial. Consequently, recurrence of symptoms or even deterioration after initial improvement following surgery is not uncommon and is a big worry in managing this menacing problem and persists to be a big challenge.

Here, we describe a technique, where we have targeted and tried to address all possible symptoms based on the basic pathology of shallow overcrowded posterior fossa as well as to maintain the surgical modifications continually to prevent recurrence. Our surgical technique is a custom-made combined surgical adaptation fundamentally based on the existing procedures with perception of our own philosophy.

MATERIALS AND METHODS

Patient characteristics

Totally 7 male and 4 female adult symptomatic patients of Chiari malformation type I (CMI) with syringomyelia (SM) underwent titanium mesh "Stealth Cranioplasty (SCP)" following posterior fossa limited bony decompression, arachnoid preserving duraplasty (APD) with hexagonal tenting of the duraplasty with the cranioplasty (HTDC) mesh from November 2012 to April 2017. Medical records, radiographical features, and outcomes determined by patient interviews and clinical evaluations were retrospectively assessed. Patients of symptomatic CMI with SM of an age > 18 years who underwent "SCP" with at least one preoperative and one postoperative magnetic resonance imaging (MRI) were enrolled in this study. Patients having craniocervical bony anomaly like atlantoaxial dislocation or basilar invagination, hydrocephalus, and history of meningitis, history of previous posterior fossa decompression (PFD), or shunt surgery were excluded.

Clinical and imaging assessment

Clinical and radiological assessments were performed preoperatively and during follow-up. Preoperative assessments consisted of duration of symptoms and neurological features. Extent of tonsillar herniation and syrinx levels and diameters were evaluated from pre- and postoperative craniocervical MRI. After surgery, neurological outcomes and complications were assessed at one and 6 months follow-ups up to

1 year and then yearly. Patients underwent craniocervical MRI 6 months after surgery, and this was repeated depending on the clinical evolution and previous MRI findings. MRI was used to determine the postoperative diameter of the syrinx and expansion of cisterna magna volumes with assessment of tonsillar ascent in the mid sagittal plane. Syrinx improvement was defined as a decrease in the maximal syrinx diameter on MRI. Outcome assessment was evaluated according to Chicago Chiari Outcome Scale (CCOS).

Surgical technique

Under general anesthesia, the patient is placed prone on sand bag rolls in a modified Concord position with the head in neutral position. Meticulous caution is taken so that the head is maintained strictly in neutral position.

A midline incision is made from 2 to 3 cm above inion to C3. The suboccipital bone is exposed from inion to the foramen magnum. The posterior arch of C1 is also exposed. During exposure, a patch of graft from the investing layer of the deep cervical fascia, measuring approximately 5 cm × 1.5 cm is harvested and is preserved for duraplasty.

A midline posterior fossa craniectomy, measuring 3 cm in length from the foramen magnum upward and 2.5 cm in total width is performed. Sometimes, we extend this upward up to the inion if the bone is thick, assessed from the preoperative images to make more space in the posterior fossa. The posterior arch of the C1 is also removed to an extent of 1 cm on both sides from the midline [Figure 1]. This small craniectomy and removal of the posterior arch are enough to accomplish our desired purpose.

Under the microscope, the dura is opened very meticulously in the midline in a linear fashion vertically, preserving the



Figure 1: Peroperative picture showing the extent of craniectomy and extent of removal of C1 posterior arch

arachnoid to a length from mid of C1 posterior arch to 5–10 mm below the upper margin of the craniectomy. Six tacking sutures are taken from the margin of the opened dura, so that, when pulled up, it takes the shape of a hexagon, arachnoid being the roof of it [Figure 2]. Any accidental breach in the arachnoid during durotomy is sealed with low power bipolar cautery. The bands on the dura, which is seen very often are not disturbed, except in the line of durotomy, as we feel that unnecessary. Rather these bands later help us in making the tacking stitches easier, stronger, and more durable.

The fascial graft is sewn in the dural opening for the duraplasty to craft the roof of the hexagonal tent, which is accomplished only when the tacking sutures are tacked with the cranioplasty construct [Figure 3].

A 5 cm × 5 cm titanium mesh is bent in a longitudinally split half cone manner in the midline which is almost flat superiorly to merge with the occipital bony contour. The wider base of the half cone is in the inferior portion to make room at and around the foramen magnum. From the lateral margin of the half cone, the mesh is bent outward to fit with the occipital surface beyond the craniectomy. The mesh now takes the shape like that of a "Stealth bomber" [Figure 4a-c]. Further, the lower part of the cone is cut in a small crescent fashion to provide more space around the craniocervical junction (CVJ).

Cranioplasty is accomplished by fixing this preshaped titanium mesh with 5 mm × 1.5 mm screws so that the flat part merges with the upper margin of the occipital bone. The lower part is fixed in such a way that the craniectomy gap is maintained at 2.5 cm in the midline longitudinally, and abundant space is formed in the midline, especially around the foramen magnum, to reestablish adequate cerebrospinal fluid (CSF) flow and let the impacted cerebellar tonsils to dislodge, come back, and accommodate in the newly created space. The tackings are fixed with the cranioplasty mesh in a way so that the duraplasty patch is elevated toward the elevated part of the mesh in a manner to accomplish the hexagonal tent [Figure 5].

Wound is irrigated with copious normal saline irrigation, hemostats is secured, and closed in usual fashion in layers with no drain.

RESULTS

Clinical and imaging findings

11 patients comprising 7 males and 4 females were evaluated in this study. Mean age of the patients was 29.45 years, ranging from 22 to 40 years. The duration of symptoms ranged



Figure 2: Perioperative picture of arachnoid preserving durotomy with tacking sutures from the dural edge

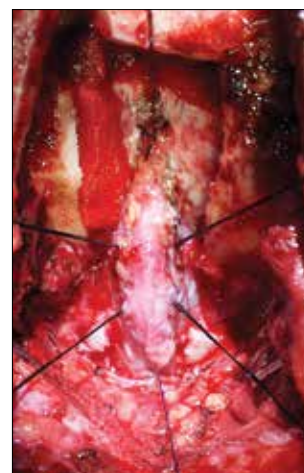


Figure 3: Perioperative picture showing the stitched fascial graft

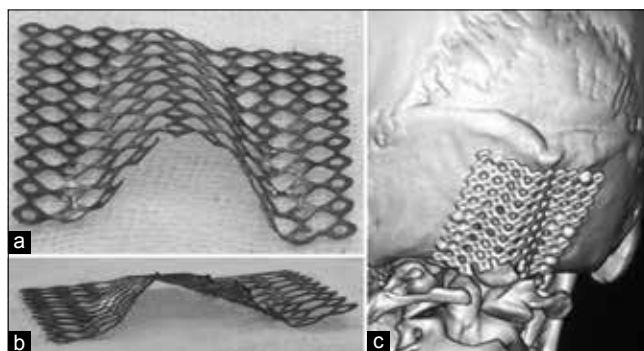


Figure 4: The Titanium mesh, preshaped as a "Stealth bomber"— superior view (a), horizontal view (b) and as seen in postoperative three-dimensional computed tomography scan (c)

from 6 to 84 (mean 37.09 months) months and follow-ups were conducted over a period of 7–54 (mean 35.90 months) months. All the patients had sensory disturbance in the form of paresthesia at presentation. Ten patients presented with neck ache while 9 and 4 patients had motor weakness of the upper and lower limbs, respectively. Suboccipital

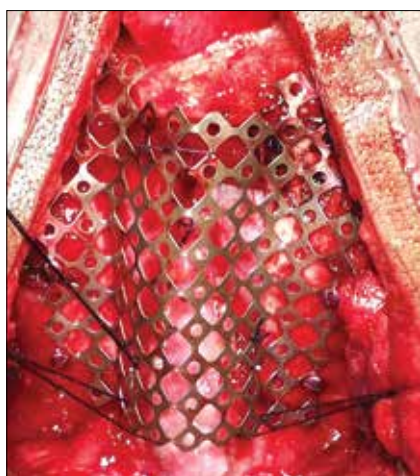


Figure 5: Peroperative picture of tenting technique of the tacking sutures with the "Stealth cranioplasty" in progress

headache was a presenting symptom in three patients. All the patients had cerebellar tonsillar descent >5 mm from the foramen magnum and none had a descent down to or below C2 level. All the patients had cervical syringes of different diameters extending to different extents. Three patients had syringes extending from 3 to 6 vertebral levels; five patients had extension from 7 to 10 levels while three patients had extension beyond 10 levels [Table 1].

Surgery and follow-up outcomes

All the patients underwent "SCP" with titanium mesh following limited posterior fossa craniectomy, APD, and hexagonal tacking of the duraplasty with the cranioplasty mesh. Eight patients following surgery enjoyed improvement of most of the symptoms while three patients continued to have unchanged status, and there was no deterioration of symptoms in any of the patients. CCOS was 13–15 in eight patients indicating improvement while three patients remained unchanged with CCOS of 12. There had been good reestablishment of cisterna magna with good flow of CSF around the foramen magnum in nine patients in postoperative MRIs at different intervals of follow-up, and variable resolution of syringes was observed in different patients [Figure 6]. Two patients had marked reduction in syrinx diameter while there was moderate and mild reduction in five and three patients, respectively. One patient had no change in his syrinx [Table 2]. Although the resolution of the syrinx was not uniform, the clinical outcomes were mostly good. None of the patients needed redo surgery, and there was no complication related to surgery.

DISCUSSION

Controversies regarding pathophysiology and management of CM are an ongoing debate since its first description because



Figure 6: T2-weighted sagittal magnetic resonance imaging image showing preoperative (a) and postoperative, (b) status of the syrinx (small black arrows in a and b), and cisterna magna (big black arrow in a and big white arrow in b)

Table 1: Demographic data of patients who underwent "Stealth cranioplasty" for Chiari I malformation associated with syringomyelia

Attribute	Number of patients (n=11)
Gender	
Male	7
Female	4
Mean age in years (range)	29.45 (22-40)
Clinical symptoms	
Sensory disturbance	11
Neck ache	10
Upper limb weakness	9
Lower limb weakness	4
Sub occipital headache	3
Duration of symptoms in months	
1-12	2
13-24	3
25-36	2
37-48	2
49-60	1
>60	1
Extension of syrinx (levels)	
3-6	3
7-10	5
>10	3

of its complex and formidable nature. The pathophysiology of CM and associated SM, which often complicates the condition, seem to be the same.^[1] Though disputed and the dilemma still continues, development of CM is most accepted to be a developmental anomaly of mesenchymal component of the occipital bone.^[2-9] This makes the posterior fossa shallow which is insufficient for the neural components to be accommodated adequately, which leads to overcrowding of the neural structures around foramen magnum leading to herniation of the cerebellar tonsils through the foramen magnum. This

Table 2: Outcome data of the patients who underwent "Stealth cranioplasty"

Parameters	Number of patients (n=11)
Clinical outcome	
Improved	8
Unchanged	3
Worsened	0
CCOS	
13-16	8
9-12	3
<12	0
Radiological outcome of syrinx	
Marked reduction	2
Moderate reduction	5
Mild reduction	3
No reduction	1
Worsened/enlarged	0

CCOS - Chicago Chiari Outcome Scale

sequence of happenings is very much in concordance with the Monro–Kellie doctrine of constant total intracranial volume.^[7,10-13] We feel that the basic pathology of CM is the anomalous shallow posterior fossa, and our surgical strategy is to try to render the posterior fossa capacious for reversal of the symptoms. Herniated and impacted neural tissues consequently block the natural CSF passage and change the CSF dynamics in the CVJ, mostly around the foramen magnum, giving rise to SM in many cases. Several theories such as "water hammer theory" of Gardner,^[14] "cranial spinal dissociation hypothesis" by Williams,^[15] "perivascular CSF push theory" by Oldfield^[16] or "intramedullary pulse pressure theory" by Greitz^[17] have been popular regarding the formation of syrinx. Whatever theory is apt, the problem lies in the alteration of CSF dynamics at and around the CVJ. Target of our surgical technique is to reestablish the CSF flow with natural dynamics which will continue to persist with minimum intervention. In (CMI), the compressive features of the upper cervical spinal cord and the lower brain stem are principally related to the tonsillar herniation and the commonly found symptoms of pain and sensory disturbances related to syrinx, are all eventually the result of a shallow posterior fossa.^[18] However, a small number of studies also revealed some CMI patients with normal posterior fossa volume in comparison to normal individuals.^[11,19] Although some studies have shown that the Chiari patients may have normal volume of posterior fossa, we feel that even with normal volume posterior fossa, patients would benefit from decompression and reconstruction to make the posterior fossa voluminous by relieving the affliction of overcrowding because of the reestablishment and maintenance of the CSF flow and dynamics.

At present, there is little or no consensus on the most effective management of CM, with or without SM. Because

of the nature of this disorder and its natural diversity in clinical presentation and on imaging, as well as its relative infrequency, it is difficult to come to an agreement on which is the best way to manage this condition. Some authors advocated to manage these patients in the pediatric as well as in adult groups, depending on the presentation in milder forms of symptoms conservatively, but surgical outcome is better than conservative management, both in reduction of tonsillar herniation, resolution of syrinx, and in overall outcome.^[20-24] Definite criteria and indications of surgery for CMI remain undefined, and still, there is no single definitive treatment protocol that is set unanimously.^[21,25-28] However, almost all surgical approaches in the past and the present use have one thing in common - a suboccipital craniectomy with removal of posterior arch of C1 though there are controversies regarding the extent of it and additional measures taken along with. Management of the dura includes leaving the dura intact with removal of the constricting band only,^[18] dural scoring,^[29,30] resecting the outer layer of the dura,^[24,27,31,32] opening the dura and leaving it open,^[33-35] and performing a duraplasty.^[8,11,18,24,31,36-40] The arachnoid manipulation similarly varies from leaving it intact,^[18,31,41] to opening and resecting it.^[1,8,34,36-40,42] The cerebellar tonsils have been addressed in various ways also like not to touch them,^[43] dissect to separate them,^[36,44] shrinkage by bipolar coagulation,^[8,24,37,39,40,45,46] and to subpial resection.^[1,8,11,24,42,46,47] In our opinion, it is best to do an APD with autologous fascia. As we do not open the arachnoid, we never touch the tonsils. Moreover, we strongly believe that there is no need to do so. When the decompression is adequate, the tonsils most of the times go back to their new abode, the expanded posterior fossa, and this reestablishes the normal CSF flow as well. For the management of syrinx, many options such as syringostomy,^[35] plugging of the obex,^[1,35,48] terminal syringostomy,^[35,49] ventriculo-caval CSF diversion,^[33,35] ventriculo subarachnoid shunt,^[47] syringosubarachnoid shunt,^[25,31,42,46] syringoperitoneal shunt,^[36] syringopleural shunt,^[34] syringocisternostomy,^[42,50] ventriculoperitoneal shunt,^[42] and lumboperitoneal shunting^[48] have been tried. All these in addition to a suboccipital craniectomy with the removal of posterior arch of C1 have been used and still are in use in different combinations or alone. But now, it is more or less established that, when the CSF flow around the foramen magnum is reestablished, the syrinx disappears.^[18,32] There is well-documented evidence that posterior craniovertebral decompression can lead to reduction in syrinx size in the majority of cases.^[44,51-54] We strongly feel that there is no reason to take any additional measure to manage the syrinx as tonsillar herniation and development of syrinx are of the same pathophysiological origin, and once the basic pathology of shallow posterior fossa is handled by making it commodious,

all the things start to revert to normalcy with time though that may vary in a very wide range.

A big concern in the management of CM is recurrence of symptoms. This happens because of a number of factors. The persistent compression of the cerebellar tonsils with inadequate CSF spaces around the inferior aspect of the cerebellum may be caused by inadequate osseous decompression, persistent occipito-atlantal membrane, or an excessively tight, or restenotic, dural closure. Scarring, inflammation, and partial calcification of the grafts, in cases of artificial dural graft, have been reported also. Arachnoiditis, with intradural adhesions and scarring following arachnoidal and tonsillar manipulation too, is a big factor for recurrence. Scarring process may adhere the dural graft, especially in cases of nonautologous dural patches, to the surface of cerebellar tonsil or vermis when the arachnoid is opened, causing the recurrent symptoms.^[55-57] Another important reason in our consideration, which is often ignored, is the recompression on the neural tissue around the foramen magnum by repositioning of muscle bulk of the neck. The muscle bulk is repositioned after craniectomy with or without duraplasty, but as there is no protection from back, possibility of some recompression is always there. This was evident in many of our postoperative MRIs of the patients that presented to us with recurrence of symptoms before doing the expansive cranioplasty. Cerebellar slump causing blockage of the CSF pathway is another reason for the recurrence of symptoms. Attempts with partial cranioplasty or tenting of the dural graft have been advocated in some literatures.^[1,8,13,58,59] We felt that, in conventional procedures, there is no measure to protect the dura from compression by the muscle bulk and scar tissue postoperatively. Initially, our goal was to prevent both by cranioplasty. Eventually, we felt that this cranioplasty can serve as a means to increase the posterior fossa volume as well. We modeled the titanium mesh in such a manner that, it would increase the posterior fossa volume in the midline to allow creating a bigger, effective and persistent CSF space, protect the dural decompression from posterior compression by displacement of muscle bulk, and keep the craniectomy to a suitable dimension so that, it provides enough space to decompress the brainstem and spinal cord but at the same time would prevent cerebellar ptosis as well. Hence, the shape was modified more or less like a "Stealth bomber," thus we named it "SCP."

Reconstruction of the posterior fossa by expansile cranioplasty is not practised routinely following PFD for the CMI. Many authors have tried posterior fossa reconstruction with cranioplasty after PFD in many ways with different objectives. Cranioplasty mainly as an attempt to prevent further cerebellar

subsidence during redo surgery has been described. Many techniques have been described in the literature such as partial cranioplasty with methyl methacrylate,^[58,60] with autologous bone,^[4,59,61-64] and cranioplasty with different varieties of titanium prosthesis.^[13,65-67] Tacking of duraplasty with or without cranioplasty has also been described by some authors with intention to keep the cistern patent and to prevent adhesion.^[13,59,62,66,68] We have tried to blend the procedures in an effective and least invasive way to give the utmost benefit to the patients.

Most of the surgeons prefer positioning the patient during surgery in the prone position with neck in neutral or slightly in flexion. Some preferred to perform surgery in semi sitting, lateral decubitus, or even keeping the patient in Trendelenburg position.^[4,8,29,32-34,36,39,41,46,47,69] In our technique, position of the patient during surgery plays a very vital role. We place the patient prone on sand bag rolls in modified Concord position. The neck is kept in the neutral position with two objectives. First, if the neck is flexed more than neutral, there is more chance of compression on the already endangered brain stem and spinal cord by the compression of herniated tonsils around the CVJ which carries more risk of compromise of the neural structures. Second, this neutral position gives a very good idea about the anatomy and architecture of the area preoperatively and helps in visualizing and planning the decompression and placement of the implant.

We developed our technique based on our observations and philosophies to manage those.

First, from our experience and supported by different literatures, we strongly believe and well convinced that congenital shallow posterior fossa is the basic pathology of CM. The small posterior fossa causes overcrowding of the neuronal structures around the foramen magnum leading to herniation. This consequently causes changes in CSF dynamics leading to syrinx in many cases. The flatness or the horizontal orientation of the basiocciput causing shallow posterior fossa and crowding around the foramen magnum gave us the occasion to think about crafting some space for the neuronal contents in the posterior fossa. We wanted to augment the posterior fossa volume so that, the herniated contents can come back and can be accommodated with ease in the newly formed location and can relieve the compression around the foramen magnum to get the anatomy and physiology, including CSF dynamics back to near normal.

Second, many patients comeback with the recurrences of symptoms after PFD with or without duraplasty and without

reconstruction at various periods of time for follow-ups. With careful study of the follow-up MRIs of this group of patients with recurrence, we found compression of the neuronal elements as well as obliteration of posterior CSF column, around the foramen magnum again by muscle bulk, and fibrous tissue from posterior aspect around the surgical site. We often found that this makes the posterior fossa shallow again, and in some cases, even smaller than preoperative dimensions. This seemed to be due to having no protection against recompression from posterior aspect. This led us to think about cranioplasty to make a protective shield against any compression from posterior aspect to avoid recurrence of symptoms.

Third, as we believe that overcrowding of the contents of the posterior fossa is the basic pathology in CM, it is most likely to have a cerebellar slump when a larger craniectomy is done to manage the overcrowding. This might be due to release of pressure in the posterior fossa creating too much space and the slump can further be aided by gravity. Although we do not make the craniectomy bigger than 2.5 cm wide and 3–3.5 cm vertically, this cranioplasty helps in preventing the cerebellar ptosis, even if there is any chance at all. We have the advantage of customizing the craniectomy by bending and shaping the titanium mesh, as we want to and get our desired cranioplasty. In most of the cases in the literature, the cranioplasty is placed at the upper part of the craniectomy defect to prevent cerebellar slump. However, we have put the cranioplasty all the way of the craniectomy to make the posterior fossa roomy in the midline. The cranioplasty mesh is designed in such a way that it reconstructs the foramen magnum as well and the foramen magnum is rendered spacious enough to relieve compression to maintain the homeostasis around the foramen magnum. The craniectomy itself is a part of decompression, and the duraplasty enlarges the space for cistern magna. The tentings of the duraplasty with the mesh prevent obliteration of CSF passage with time. The whole cranioplasty mesh construct serves in several ways (i) it forms enough space to enlarge the posterior fossa to accommodate the herniated tonsil; (ii) it makes enough space by means of keeping the hexagonal duraplasty in place to reestablish CSF dynamics and keeps the newly formed cisterna magna patent to ensure free flow of CSF continually around the CVJ; (iii) it prevents recurrence related to posterior compression by the postoperative scar and muscle bulk; and (iv) it supports the cerebellum from sagging down.

Fourth, APD has the advantage of preventing postoperative arachnoiditis related to surgery. Manipulation of the arachnoid escalates arachnoid scarring and arachnoiditis which is further augmented by seepage of blood into the

subarachnoid space and exaggerates the risk of adhesion with the cerebellar surface, dura or the duraplasty. All these together may jeopardize the benefit of the surgery and may cause recurrence or even deterioration of the symptoms sometimes. As the Pascal's law states, any force in a closed fluid filled container is equally distributed to all directions with the same force, our hypothesis is that the force of CSF in the new space, aided by brain pulsation is capable of opening up any adhesion of the arachnoid or creating new pathway naturally, to reestablish the CSF flow to near normal. Moreover, as the bigger CSF space is molded and maintained by APD and HTDC, the CSF makes its way to the spinal subarachnoid space to equilibrate the pressure gradient with the cranial CSF. This CSF equilibrium has the potential to push the tonsils up, back to the newly formed space and keeps it floating with the buoyancy to prevent it from going down again and castoffs the need to handle the tonsils as well. Initially, the new space is enlarged moderately to relieve the symptoms. With time and CSF pulsation the space expands more and takes the contour of the cranioplasty and is maintained very well making the posterior fossa volume and CSF dynamics adequate to sustain relief of symptoms. This is why we make the craniectomy less wide and craft the cranioplasty in such a way that the volume of the posterior fossa is increased in the midline around the foramen magnum. APD also has the advantage of avoiding CSF-related complications such as CSF leak, meningitis, and pseudomeningocele formation. Following PFD, APD, HTDC, and SCP, the syrinx resolves in most of the cases without taking any additional measure for managing syrinx. This is, in our opinion, is due to reversal of CSF dynamics to normalcy. Although in a good number of cases, the syrinx takes long time to resolve or does not resolve appreciably, the symptoms related to syrinx resolve markedly.

Fifth, a big issue in cases of CM is postoperative complications which differ in different literatures. Complication rates between 15% and 25% after dural opening procedures have been reported while the complication rate after nondural opening procedures is amazingly as low as 2%–6%.^[29] Complications that are encountered commonly related to surgery are hemorrhage, CSF leak, meningitis, pseudomeningocele, inflammatory reaction involving the dural graft, hydrocephalus, subdural hygroma, wound infection, large craniectomy and/or duraplasty and cerebellar sag, occipital nerve pain, and inadequate decompression.^[1,18,32,37,46,55,70-72] Fortunately, we did not face any complication postoperatively. It is reasonable to say that, APD especially helped in preventing the CSF-related complications. The APD with autologous fascia and hexagonal tacking of that with the "Stealth" cranioplasty

prevents the chances of aseptic meningitis, inflammatory reaction, scarring, and adhesion related to the dural graft and cerebellar sag. The cranioplasty also serves to keep the decompression to continue effectively by preventing compression from behind again by fibrous tissue or relocating of the muscle bulk back.

Finally, financial and psychological burden other than physical disability takes a heavy toll on the patients and families. With our technique, it is intended to reduce those in every possible way. This is achieved easily by doing this simple technique, which is relatively cheap and affordable by the patients of a low socioeconomic condition like ours. At the same time, with this minimal expense, patients can avoid further extra expenses from resurgery and rehabilitation.

CONCLUSION

The goal of our surgical technique, as practiced conventionally elsewhere, is the reconstruction of a more capacious posterior fossa to decompress the spinal cord and lower part of brain stem to relieve symptoms, to reestablish and maintain free circulation of CSF in its natural pathway, to reduce chances of complications as much as possible with emphasis on the prevention of recurrence by maintenance of the decompression. We developed our technique with the philosophy to achieve our desired outcome with the minimal intervention and with least disturbance of nature. Considering all, we innovated this technique based on our experience and judgments and we feel that this technique embraces most of the aspects.

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Conflicts of interest

There are no conflicts of interest.

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