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Original Article

Posterior Fossa Decompression with And without Duraplasty in Adults with Chiari Malformation Type 1: Comparative Study

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BACKGROUND: The widely accepted management for patients with symptomatic Chiari malformation type 1 (CM-I) is the decompression of posterior fossa. Adding duraplasty still has no general consensus.

OBJECTIVE: To identify the impact of duraplasty on clinical outcomes in adult CM-I patients.

PATIENTS AND METHODS: Retrospectively, eighteen adult CM-I patients with syringomyelia were included. Patients underwent decompression of the posterior fossa either with duraplasty (decompression plus duraplasty group) or without duraplasty (only decompression group). The impact of duraplasty on short-term (after one and three months) and on long-term (after 12 months) clinical outcomes was compared between the two groups.

RESULTS: Eleven patients (61.1%) were operated by decompression plus duraplasty, and 7 patients (38.9%) underwent only decompression. Hospital stay was significantly longer in decompression plus duraplasty group ($p = 0.037$). CSF leak was the only postoperative complication with significant difference ($p = 0.038$). A statistically significant high rate of complications was observed in cases with synthetic dural graft. Postoperative syrinx regression was statistically significant in decompression plus duraplasty group ($p = 0.024$). Short-term outcome results were non-significant between the two groups, however, clinical outcome after 12 months of follow up was significantly better in decompression plus duraplasty group ($P = 0.025$).

CONCLUSION: Despite having a longer average hospital stay and a slightly higher rate of complications, decompression plus duraplasty can be associated with significant syrinx regression and a better long-term clinical outcome than decompression alone. Autologous fascia lata graft seemed to be more reliable for duraplasty with fewer complications.

KEYWORDS: Chiari Malformation, Decompression plus Duraplasty, Syringomyelia.

BACKGROUND

Multiple types of Chiari malformation (CM) do exist. Chiari malformation type I (CM-I) is mostly seen in adults and it refers to the degree of descent of cerebellar tonsils under the basion-opisthion line seen on magnetic resonance imaging (MRI).[1] The etiology of CM is still a matter of debate; and although multiple theories were proposed to explain its pathophysiology, still there is no general consensus regarding any of which.[2-4]

CM- I is commonly associated with central spinal cord dilatation because of syringomyelia.[5] Clinical signs in patients with (CM-I) can be attributed to compression of the neural structures or a result of syringomyelia.[6,7] Pain is the most frequent symptom that can be expressed in the occiput, neck or in the upper limbs. Numbness, muscle weakness, gait disturbance and ataxia are among the clinical manifestations.[7,8]

Controversy still exists regarding which is the substantial management for (CM-I). The two main surgical modalities that gained considerable acceptance among neurosurgeons include posterior fossa decompression alone or plus duraplasty and the second modality is the use of different types of shunt techniques to minimize the cavity of syringomyelia. The possibility of spinal cord injury with shunt techniques, had given the priority to the posterior fossa decompression which still remains the surgical modality with wide acceptance for CM-I management.[8,9]

In literature, multiple researches comparing decompression plus duraplasty versus decompression alone have been performed but most of which were only concerned with pediatric population.[10-12]

In adults CM-I patients; performing duraplasty remains controversial. We retrospectively evaluated the pre and postoperative data of adult patients diagnosed with CM-I with concomitant syringomyelia who were operated with posterior fossa decompression alone or plus duraplasty. Our objective was to identify the impact of duraplasty on short and long-term clinical outcomes in these patients and to compare artificial materials versus autologous fascia lata graft used for duraplasty.

PATIENTS AND METHODS

This retrospective comparative research was conducted on patients with CM-I who underwent decompression of the posterior fossa either with duraplasty (decompression plus duraplasty group) or without duraplasty (only decompression group) in our neurosurgical department from June 2019 to January 2022. This research was

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approved by the clinical research committee of our institution (Institutional review board IRB approval number: 2-2023.NEUS 1-2).

Patients above 18 years who had symptomatic CM-I associated with syringomyelia in MRI examination were included in our study. We excluded; patients with other craniovertebral junction pathologies (Malformation, tumors, infections or trauma), patients with other types of Chiari malformation, patients without syringomyelia in MRI, and patients who did not continue for follow up.

Epidemiological information, clinical presentations, radiographic findings, and postoperative patients' neurological condition were gathered from patients' files in our institution then were reviewed and compared. Consent from patients for the operation was kept in the patients' files.

Clinical evaluation included age, gender, main symptoms and its duration, clinical sings, duration of hospital stay and postoperative complications. MRI examination of the brain and craniovertebral junction was done for all cases. CM-I was diagnosed by the presence of cerebellar tonsillar descent ≥ 5 mm below the foramen magnum. Syrinx location was confirmed by spine MRI and was categorized as limited to cervical region or extending beyond cervical region.

After a written consent was signed by the patient, surgery was done with patient in the prone position; Mayfield was used to fix the patient's head with slight flexion of the neck. Skin incision was performed in the midline from the occipital protuberance to the spinous process of the second cervical vertebra, followed by exposing the edges of the occipital bone and the posterior arch of C1 and C2. The bony decompression was achieved through removal of the lower part of the occipital bone, C1lamina, and tip of C2 spinous process (about 4 cm x 4 cm). Afterwards, the thickened tissue compressing the dura was recognized and excised.

In cases of duraplasty, a midline dural incision was made and the inferior pole of cerebellar tonsils and spinal cord in the cervical region were exposed. Whenever scarring or adhesions of the arachnoid were recognized, it was removed through sharp dissection. Dural closure was then done using a dural graft with either autologous fascia lata graft or artificial dural graft. Performing a duraplasty in addition to bony decompression of the posterior fossa was the choice of each neurosurgeon based on surgeon's preference. In this study, no neurosurgeon did the two surgical procedures.

All the included cases were contacted through a phone call. Consent to be included in the study and consent for publication was gained from each participant. Postoperatively, clinical outcome results were observed at 3 different time points during follow-up: short-term results (after one and three months) and long-term results (after 12 months).Postoperative outcomes were categorized as excellent results (improved) if improvement of the patient symptoms and signs was achieved, good results (stabilized) if there was no progression of the symptoms and signs; and poor results (worsened) if the patient developed further deterioration of neurological function.

Follow-up MRI was done for all cases after 3 months to record the regression of syringomyelia. **(Fig. 1)** illustrates the pre and postoperative MRI of a CM-I adult female patient who underwent decompression plus duraplasty.

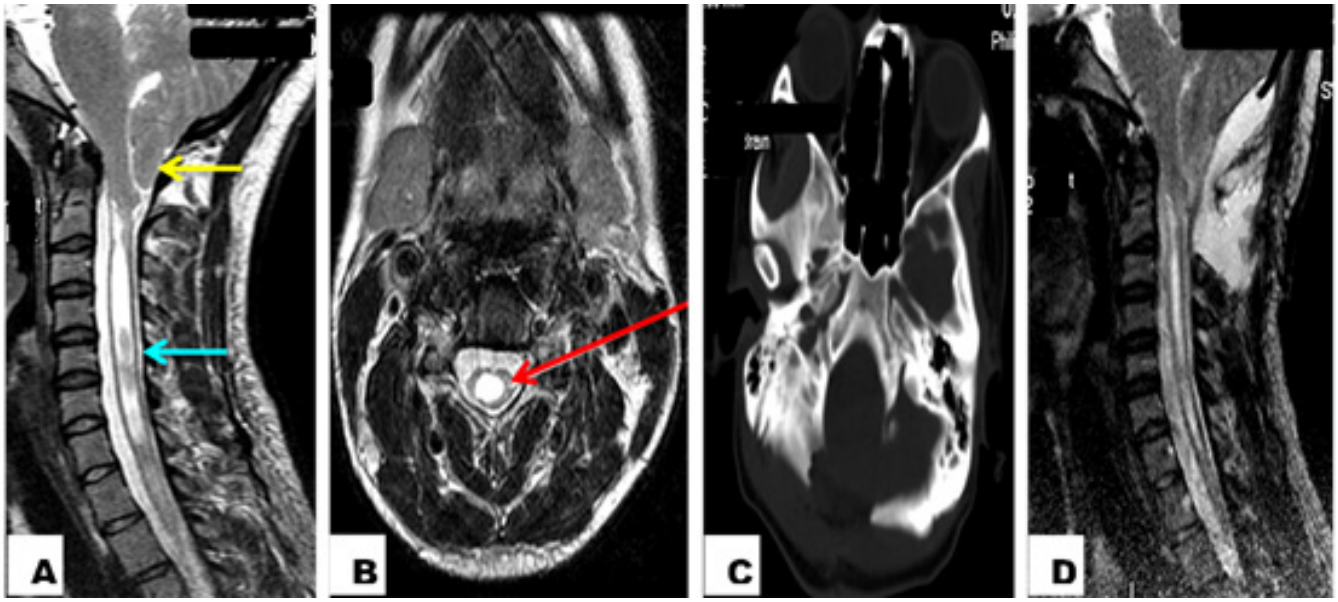

Fig 1 (A-D): Adult female diagnosed with CM type-I and underwent decompression plus duraplasty in our neurosurgery department. A: Preoperative T2 sagittal MRI showing cerebellar tonsillar herniation through foramen magnum (yellow arrow) and central spinal canal dilatation corresponding to syringomyelia (blue arrow); B: Preoperative T2 axial MRI showing tonsillar herniation through foramen magnum (red arrow); C: Postoperative computed tomography CT (bone window) showing the suboccipital craniectomy; D: Postoperative T2 sagittal MRI showing slight regression of the syrinx cavity.

Statistical analysis: For statistical analysis of our results, the statistical package for social sciences (SPSS) version 22 (IBM Corporation, 1 Orchard Rd, Armonk, NY 10504, USA), and Microsoft Excel 2010 (Microsoft Corporation, One Microsoft Way Redmond, WA 98052-6399 USA). Descriptive statistics included mean (x), and standard deviation (SD). Count data were statistically analyzed using the chi-square test (X2). To compare the results among the two studied groups, an independent sample t-test (t) was used. For comparing different pre- and postoperative means, paired samples t-test was used. P values that were ≤ 0.05 were reported as statistically significant.

RESULTS

Among included cases, 11 patients (61.1%) were operated upon through decompression plus duraplasty, while 7 patients (38.9%) underwent only decompression. The range of patients' age was from 22 to 52 years. Females constituted the majority of cases (61.1%). Table 1 compares the general, clinical and radiographic data of patients in the two studied groups. Regarding the patients' age, sex, symptoms duration, preoperative clinical presentations or location of syrinx in MRI, we did not find significant differences between the two groups.

Postoperative complications were observed in 6 (33.3%) out of the 18 included cases. Notably, some cases developed more than one complication. **Table 2** demonstrates the distribution of postoperative complications among patients of the 2 groups.

In the (decompression plus duraplasty group), fascia lata graft was used for duraplasty in 8 cases (72.7%) while artificial dural graft was used in 3 cases (27.3%). A statistically significant high rate of complications was observed in cases with artificial dural graft. **Table 3** demonstrates the distribution of postoperative complications among patients who underwent duraplasty.

In regard to the whole sample, duration of hospital stay was (14.56 ± 5.437) days. It was significantly longer in decompression plus duraplasty group (16.64 ± 5.316) than in only decompression group (11.29 ± 4.030) where (p = 0.037). In the follow up MRI, syrinx regression was recorded in (61.1%) of cases while (38.9%) had no change regarding their syrinx. As illustrated in **(Fig. 2)**, postoperative syrinx regression was statistically significant in decompression plus duraplasty group (P = 0.024).

Table 4 demonstrates the clinical outcomes among patients of the 2 groups. Short-term outcome results (After one and three months) were non-significant between the two groups, however, clinical outcome after 12 months of follow up was significantly better among patients who had duraplasty (P = 0.025).

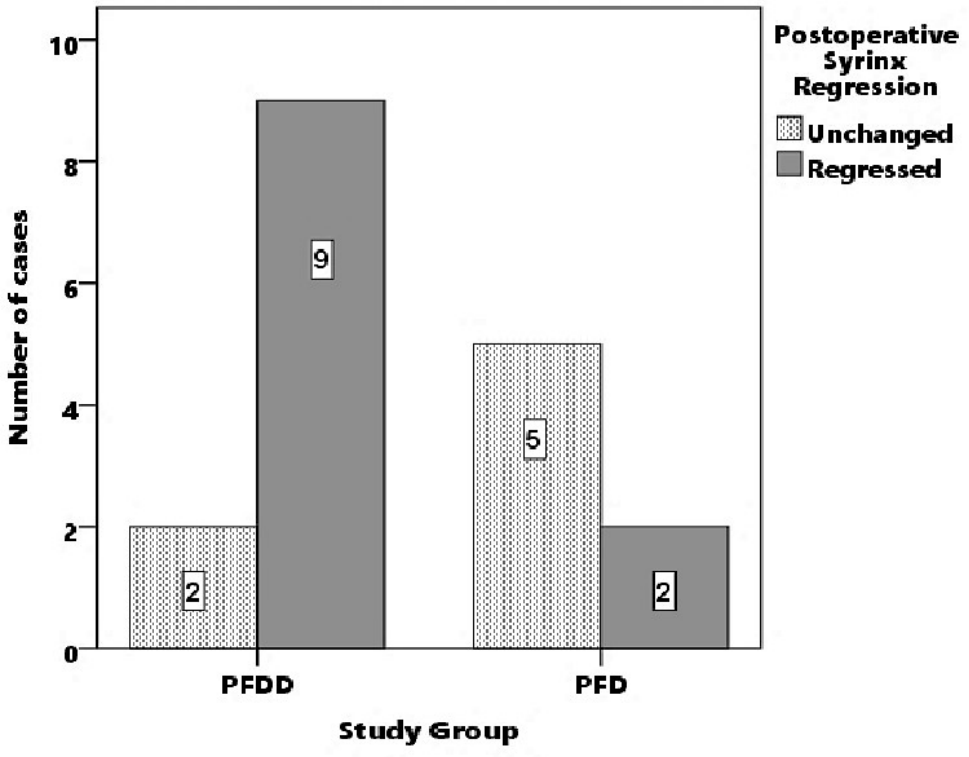

Fig 2: Syrinx regression among the two studied groups: Postoperative syrinx regression was recorded in 9 patients in posterior fossa decompression plus duraplasty (PFDD) group versus 2 cases in the only posterior fossa decompression (PFD) group (P = 0.024).

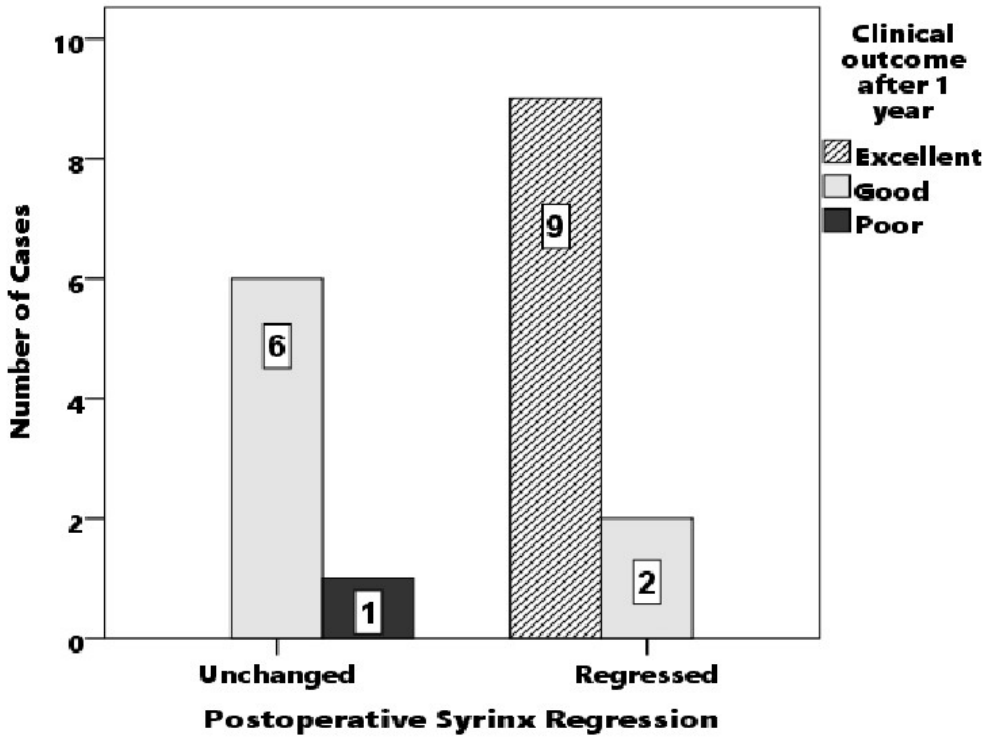

Fig 3: Impact of postoperative syrinx regression on the long-term outcome: Postoperative syrinx regression was recorded in 11 cases; 9 cases of them had an excellent long-term outcome and 2 cases had good outcome. On the other hand, 7 cases had no postoperative syrinx regression; 6 cases of them showed good outcome and one case had poor outcome. The postoperative syrinx regression was significantly correlated with better long-term clinical outcome (X2 = 11.688 and P = 0.003).

Table 1: Preoperative general, clinical and radiographic data of patients in the two groups

Data	Entire sample (n = 18)	Decompression plus duraplasty (n = 11)	Only decompression (n = 7)	p value
Age in years (mean ± SD)	35.78 ± 8.447	35.36 ± 8.237	36.43 ± 9.396	0.803
Sex				
Male	7 (38.9%)	4	3	0.798
Female	11 (61.1%)	7	4	
Duration of symptoms (months)	30.11 ± 8.878	29.27 ± 7.390	31.43 ± 11.356	0.630
Clinical Presentations				
Headache	17 (94.4%)	11	6	0.220
Neck pain	14 (77.8%)	9	5	0.630
Numbness	12 (66.7%)	7	5	0.751
Weakness	6 (33.3%	3	3	0.523
Ataxia	3 (16.7%)	2	1	0.841
Gait disturbance	4 (22.2%)	2	2	0.630
Location of Syrinx				
Cervical	6 (33.3%)	3	3	0.523
Beyond Cervical	12 (66.7%)	8	4	

Table 2: Postoperative complications among patients of the two groups

Complication	Entire sample (n = 18)	Decompression plus duraplasty (n = 11)	Only decompression (n = 7)	p value
Re-operation	2 (11.1%)	1	1	0.751
Wound infection	3 (16.7%)	2	1	0.841
Aseptic meningitis	2 (11.1%)	2	0	0.257
CSF Leak	4 (22.2%)	4	0	0.038*

Notes: CSF: Cerebrospinal fluid. *: Statistically significant.

Table 3: Postoperative complications among patients of the decompression plus duraplasty group

Complication	All Patients (n=11)	Fascia lata graft (n=8)	Artificial dural graft (n = 3)	X^2	P value
Re-operation	1	0	1	2.933	0.087
Wound infection	2	2	0	6.519	0.011*
Aseptic meningitis	2	1	1	0.637	0.425
CSF leak	4	3	1	7.219	0.007*

Notes: CSF: Cerebrospinal fluid. *: Statistically significant.

Table 4: Postoperative clinical outcome results among patients of the two groups

Clinical outcome	Entire Sample (n = 18)	Decompression plus duraplasty(n = 11)	Only decompression (n = 7)	p value
After 1 month				
Excellent	6	3	3	
Good	8	6	2	0.892
Poor	4	2	2	
After 3 months				
Excellent	5	3	2	
Good	11	8	3	0.378
Poor	2	0	2	
After 12 months				
Excellent	9	8	1	
Good	8	4	4	0.025*
Poor	1	0	1	

Notes: *: Statistically significant.

DISCUSSION

Postoperative symptomatic improvement in adults with CM-I; is mostly attributed to the dynamic adjustment of CSF flow following competent posterior fossa decompression.[13] In this research, the mean age of included cases was 35.78 ± 8.447 years with a slight female predominance. Both age and sex did not significantly differ between the two groups (p= 0.803 and 0.798, respectively). This comes in accordance with some previous studies.[8,14]

Being a slowly progressive disease, the preoperative symptoms duration in CM-I patients can be mostly long.[15]

In our study, the mean duration of symptoms was 30.11±8.878 months and the difference was non-significant between the 2 groups, this is consistent with literature.[5,15-17] In the current study, the preoperative duration of symptoms did not significantly affect the postoperative clinical outcome (p = 0.656). In contrary to our result, Gurbuz and colleagues8 observed a significant difference only in patients with symptoms duration ≤ 36 months.

According to our results, occipital headache and neck pain were the most frequent symptoms. This finding comes in agreement with previous studies that addressed the CM-I.[8,18,19] On the other hand, Chen and colleagues,[17] documented that non-pain symptoms including numbness, sensory loss and weakness were observed more frequently.

Syrinx was reported in all cases included in our study and the descent of cerebellar tonsils was ≥ 5 mm. Syrinx limited to the cervical region was found in 33.3%.

of our cases, while in the remaining 66.7% syrinx extended beyond the cervical region, noticeably, this was non-significant among patients of the two groups. Chen and colleagues,[17] reported similar results where no significant difference regarding the location of syrinx was found between the 2 groups (p = 0.860).

In our series, the postoperative complication rate was 33.3%. CSF leak, wound infection, aseptic meningitis and reoperation were reported in 22.2%, 16.7%, 11.1% and 11.1% of the cases respectively. CSF leak was the only complication that showed statistically significant difference between the two groups (p = 0.038). The rate of complications in patients who underwent duraplasty was significantly higher than in those who underwent only decompression; a result that is concomitant with the literature. This can be explained by the fact that, opening and suturing the dura may destroy the dura matter integrity, increasing the possibility of CSF-related complications.

In the literature, a wide range of differences was found regarding the rate and the order of postoperative complications. Arruda and colleagues[5] reported in their study that 23% developed pseudomeningocele and 6.6% developed meningitis. Gurbuz and colleagues study,[8] reported a postoperative complication rate of 28.6% in duraplasty group versus 5.6% in those without duraplasty; in their study CSF fistula was recorded in 5.1%, meningitis in 12.8% and pseudomeningocele in 2.6% of patients. In the study of Chen and colleagues,[17] aseptic meningitis was the most frequent complication (20.3%) and the only complication that had a significant difference between the studied groups (p = 0.027). Shweikeh and colleagues18 concluded that adding duraplasty had significant procedure-related complications (p = 0.003). Postoperative complication rate was (21.1% and 21.8%) in Parker et al.[20] and Klekamp 21 studies, respectively; notably there was higher incidence of complications with duraplasty in both series.

In our case series, one patient in the decompression plus duraplasty group had postoperative persistent CSF leak and was indicated for reoperation where a fascia lata graft was used instead of the artificial dural graft. Two patients in the only decompression group had further deterioration of their preoperative complaint and were indicated for reoperation; one of them was re-operated with duraplasty while the second refused surgery. Gurbuz and colleagues8 reported in their study on 103 patients that 7 cases needed reoperation, 4 cases of them belonging to the non-duraplasty group. Shweikeh and colleagues[18] reported that patients who underwent duraplasty had a higher significant need for re-operation (2.1% versus 0.7%, p = 0.001).

Being more viable with less tissue response, fascia lata can allow good closure of the dural defect and reduce the risk of CSF leakage with better graft healing.[22] For duraplasty, autologous fascia lata graft was used in 72.7% of our cases while artificial dural graft was used in 27.3%.

A statistically significant high rate of complications was observed in cases with artificial dural graft. Our result is similar to Chen and colleagues,[17] results where duraplasty was performed using fascia lata in 9 patients with no recorded complications. Also, Aboelkhir and colleagues19 study on 28 cases of CM-I concluded that, decompression surgery with duraplasty using fascia lata showed better outcome and a significant lower rate of CSF leak. It is worth-mentioning that in order to minimize the incidence of complications mostly CSF leaks, the neurosurgeon can take care not to breach the arachnoid membranes before performing the duraplasty.

Performing duraplasty after bony decompression for CM-I patients still has no general consensus. Some authors suggested that only decompression is sufficiently effective[8,18,23,24] whereas others recommended the need for duraplasty.[25-27] Postoperatively, syrinx regression was observed in 81.8% among patients of the decompression plus duraplasty group versus 28.6% among the only decompression group; this difference was statistically significant (p = 0.024). This result is consistent with that of Gurbuz and colleagues8 study, who reported a significant higher rate of postoperative syrinx regression (p < 0.01) in patients who underwent duraplasty (92.3%) than in those without duraplasty (12.5%).

Patients in decompression plus duraplasty group had a significantly longer (p = 0.037) duration of hospital stay; this can be attributed to the time spent for managing the postoperative complications. This result comes in agreement with that reported by Shweikeh and colleagues,[18] in a large national study conducted on 1593 cases who had only decompression and 1056 cases who had decompression with duraplasty. They found that a significantly longer hospital stay (p = 0.001) was observed among patients who underwent duraplasty. On the other hand, Chen and colleagues,[17] did not observe significant difference between the 2 groups regarding either the total or the postoperative hospitalization.

In our study, the difference in short-term outcome results (one and three months postoperatively) was non-significant between the two groups, while the long-term clinical outcome (after 12 months) was significantly better in the decompression plus duraplasty group (p = 0.025). Our results come in agreement with Alexander and David study 13 that concluded that decompression with duraplasty can result in better long-term symptomatic relief, more syrinx reduction, and a reduced need for re-surgery. Also, McGirt and colleagues,[28] concluded that bony decompression without duraplasty had a 2-fold risk of symptoms recurrence in comparison to decompression plus duraplasty. Sindou and colleagues,[29] had reported favorable results with duraplasty. In contrary to our result, Chen and associates,[17] found that, both the short and long-term outcome results showed no significant difference between posterior fossa decompression with or without duraplasty. Also, Erdogan and associates,[30] found that symptomatic improvement was achieved in 83% of cases after foramen magnum decompression

without duraplasty.

As shown in **(Fig. 3)**, among the 11 cases who had regression of their syrinx, 9 cases showed excellent outcome and 2 cases had good outcome with no poor outcome results. So, postoperative syrinx regression was a statistically significant factor for better long-term outcome ($p = 0.003$). Our results are in accordance with Gurbuz and colleagues[8] who reported 84.6% improvement rate in patients whose syrinx regressed versus only 37.5% in patients without syrinx regression ($p = 0.056$).

Study Limitations

This research has some limitations because of its retrospective nature and the relatively small sample size. However, our results can be a base for larger scale prospective studies for better evaluation of the indications and benefits of duraplasty in the setting of posterior fossa decompression in adults with CM-1.

CONCLUSION

Despite having a longer average hospital stay and a slightly higher rate of complications, posterior fosss decompression plus duraplasty for adult Chiari malformation type I (CM-I) patients with syringomyelia can be associated with significant syrinx regression and a better long- term clinical outcome than decompression alone. In comparison to artificial materials, autologous fascia lata graft seemed to be more reliable for duraplasty with fewer complications.

List of Abbreviations

CT: Computed tomography.
CM: Chiari malformation.
CM- I: Chiari malformation type I.
CSF: Cerebrospinal fluid.
IRB: Institutional review board.
MRI: Magnetic resonance imaging.
PFD: Posterior fossa decompression
PFDD: Posterior fossa decompression plus duraplasty.
SD: Standard deviation.

Approval

This study was approved by the clinical research committee of the Menoufia University Hospital (IRB approval number: 2-2023.NEUS 1-2) and it followed the tenets of the Declaration of Helsinki.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this manuscript.

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Authors' Contributions

The first and second authors performed a considerable contribution to this work, in the conception; study design; analysis and interpretation of data. The two authors took part in drafting, revising and final approval.

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