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# Risk Of Meningitis Following Posterior Fossa Decompression With Duraplasty In Cases Of Chiari Malformation Type 1 And Syringomyelia

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**ABSTRACT**

**Objectives:**

1. To determine the risk of postoperative meningitis following posterior fossa decompression with duraplasty in patients with Chiari malformation type 1 and syringomyelia.

2. To determine the incidence of other postoperative complications: pseudo meningocele, CSF leak and the need for reoperation following the surgery.

3. To evaluate the association of demographic, clinical, and surgical factors, including graft type, with the occurrence of meningitis and other postoperative complications.

**Methodology:**

This prospective descriptive cohort study was conducted from January 2024 to January 2025 at a tertiary care center. A total of 60 patients aged 10–65 years undergoing PFDD were included through consecutive sampling. Patients were followed at 1, 3, 6, and 12 months postoperatively. The primary outcome was meningitis, defined by CSF pleocytosis with microbiological confirmation. Secondary outcomes included pseudo meningocele, cerebrospinal fluid (CSF) leak, and reoperation. Associations between demographic, clinical, and surgical variables, including graft type, were analyzed.

**Results:**

The mean age was 38.72 ± 16.41 years, with a female predominance (75%). The incidence of postoperative meningitis was 5%. Pseudo meningocele occurred in 8.3% of patients, while CSF leak and reoperation were observed in 5% each. Patients receiving non-autologous grafts demonstrated a higher relative risk of meningitis (RR = 3.29) and other complications; however, no statistically significant associations were found ($p > 0.05$).

**Conclusion:**

PFDD is associated with a measurable risk of postoperative complications, including meningitis, pseudo meningocele, and CSF leak. Although non-autologous grafts showed a higher relative risk, no significant predictors were identified. Larger multicenter studies are required to better define risk factors and optimize surgical outcomes

**Keywords**: Chiari malformation type I, syringomyelia, posterior fossa decompression, duraplasty, meningitis

## INTRODUCTION

Chiari malformations (CMs) refer to a range of defects in the hindbrain, especially impacting the cerebellum, skull base, brainstem as well as the cervicomedullary junction. Chiari malformations have been categorized into four types according to the extent of the brain tissue that herniates into the spinal canal, along with the abnormalities of the brain and spinal development. CMs are most prevalent in the craniocervical junction malformations that are predominantly found in adults. CM-1 is the most prevalent variant, which is characterized by the downward displacement of the cerebellar tonsils of more than 13 mm below C1 vertebral body via the foramen magnum.[1] There is currently no universally accepted definition among clinicians regarding CM-1. This is because abnormalities exhibit inconsistencies in clinical as well as radiological correlation. [2] CM-1 may be present clinically as an asymptomatic hindbrain hernia, which usually becomes evident from late childhood to adulthood. The main symptoms are tussive headaches along with focal neurological symptoms.[3,4]

Syringomyelia is a disorder characterized by cerebrospinal fluid (CSF) abnormal circulation, which results in the development of fluid-filled cavities. When it develops in the parenchyma of the spinal cord it is referred to as syringomyelia. However, when it develops into the central canal of the spinal cord it is called hydromyelia. This condition is frequently related to (CM-1) but can also result from multiple factors, including spinal cord tumors, trauma, as well as adhesive arachnoiditis.[5–7] Syringomyelia mostly presents with sensory symptoms; numbness, dysesthesia, fasciculations and painless burns etc. However, it is also often identified as a random occurrence in majority of cases. [8] The prevalence of syringomyelia is rising due to the heightened utilization of MRI in the standard assessment of pain in neck and back.[9,10]

Posterior fossa decompression (PFD) with duraplasty is an essential surgical intervention in the management of symptomatic CM-1, particularly in the cases where syringomyelia exist. This procedure is employed to mitigate crowding at the craniocervical junction, diminish or eliminate syrinx cavities as well as to re-establish CSF flow at foramen magnum. [11–13] Meningitis is a notable postoperative complication. Its potential severity and life-threatening implications warrant careful consideration. Meningitis can arise because of direct inoculation during surgical procedures and CSF leakage. The use of a dural graft, especially with synthetic materials can increase the possibility of infection in patients as it may lead to foreign body reactions/colonization. [14,15]

The surgical management of CM1 with associated syringomyelia commonly involves Posterior Fossa Decompression (PFD) with duraplasty to restore CSF flow as well as encourage syrinx regression. However, this approach introduces a risk of postoperative complications, most notably CSF leak with meningitis. Despite concerns, there remains a lack of consensus as well as robust clinical data regarding the true incidence and determinants of meningitis following PFD with duraplasty in CM1 patients with syringomyelia. Therefore, investigating this is crucial for informed surgical decision-making; guiding prophylactic strategies and improving overall patient safety along with the prognosis and treatment outcomes.

The objective of this study is to determine the risk of postoperative meningitis and the incidence of other complications: pseudo meningocele, cerebrospinal fluid leak, and reoperation, following posterior fossa decompression with duraplasty in patients with Chiari malformation type 1 and syringomyelia. It also aimed to evaluate the association of demographic, clinical, and surgical factors, including graft type, with the occurrence of meningitis and other postoperative complications.

## MATERIAL AND METHODS:

This descriptive prospective cohort study was conducted at the department of Neurosurgery of Hayatabad Medical Complex (HMC) Peshawar from January 2024 to January 2025 after getting ethical approval from the ERB committee of Khyber Girls Medical College (KGMC). The study population consisted of 60 consecutive patients aged 10 to 65 years, who were diagnosed with Chiari malformation type I associated with syringomyelia using non-probability consecutive sampling. Excluded were patients who had prior posterior fossa surgery, active CNS infection, immunocompromised status, or incomplete follow-up. The sample size was calculated assuming an expected postoperative meningitis incidence of approximately 20%, with a 95% confidence level and 10% margin of error, resulting in a required sample of 60 patients.[16,17] The primary exposure variables include were the type of dural grafts (autologous vs non-autologous), occurrence of post-operative CSF leak and development of pseudo-meningocele. Potential confounding variables that were included were age, sex, and baseline neurological deficits. Data was collected using a standardized proforma that included demographic variables (age, sex, socioeconomic status, residence), clinical features (headache, neck pain, neurological deficits), radiological findings, intraoperative details (type of dural graft), and postoperative outcomes (meningitis, CSF leak, pseudo meningocele, and need for reoperation). Selection bias was minimized by inducting consecutive eligible patients who met the predefined inclusion criteria. Information and observer bias were reduced using standardized diagnostic and laboratory criteria for outcome assessment. Potential confounding variables including age, sex, and baseline neurological status were recorded and addressed during statistical analysis. Due to the nature of the surgical procedure, blinding of surgeons and patients was not feasible; however, objective outcome definitions were used to minimize assessment bias.

All the patients underwent standardized posterior fossa decompression with duraplasty performed by a neurosurgical team following a uniform surgical protocol. The procedure involved a midline suboccipital craniectomy, extending approximately

3×3 cm in size with removal of the posterior arch of the C1 vertebra. Intraoperative ultrasound was routinely used to confirm adequate decompression of the cerebellar tonsils and restoration of cerebrospinal fluid flow at the craniocervical junction.

For the duraplasty component the surgeon selected either autologous grafts or non-autologous materials based on individual patient factors and intraoperative findings. The dura was opened in a Y-shaped fashion with careful preservation of the arachnoid layer, when possible, followed by watertight closure of the graft using non-absorbable sutures. All the patients received standardized perioperative care which included prophylactic antibiotics and were monitored in a neurosurgical intensive care unit for at least 24 hours postoperatively.

Clinical follow-up was performed prospectively at regular intervals of one, three, six and twelve months (all patients included completed the follow up) for the primary outcome, which was meningitis, defined as CSF pleocytosis (>5 WBCs/mm³) with positive cultures or PCR confirmation. Secondary outcomes assessed were pseudo meningocele and CSF leak and if the CSF leak and pseudo meningocele did not resolve by itself, then they were reoperated.

Data was analyzed with SPSS 26. Continuous variable age was evaluated using mean and standard deviation. Categorical variables such as Gender, socioeconomic status, residence (with low class <30,000 Rs, Middle class 30,000-100,000 Rs, High class >100,000 Rs), patients with sensory or motor deficits, type of duraplasty graft, meningitis and other complications were evaluated using frequencies and percentages. Comparative analysis was performed to assess the association between exposure variables and meningitis using chi-square test. Relative risks (RR) with 95% confidence intervals were calculated. A p-value <0.05 was considered statistically significant.

**RESULTS:**

The demographics of the cohort showed the mean age of the 60 patients was 39±16.41 years with a range of 10 to 65 years. There was a high female proportion with 45 (75%) female patients compared to 15 (25%) males (Table 1). 25 (41.7%) of the patients were from middle class families, while 13 (21.7%) were from lower class and 22 (36.7%) were from upper class. 26 (43.3%) lived in rural areas, meanwhile 34 (56.7%) lived in urban areas.

The analysis of clinical presentation revealed headaches to be the most frequent symptom reported by 34 (56.7%) patients, along with neck pain in 22 (36.7%) patients and, sensory or motor deficits were present in 22 (36.7%) patients (Table 2). Regarding the surgical interventions, non-autologous grafts were utilized more frequently in 46 (76.7%) cases while autografts were used in 14 (23.3%) patients (Figure 1).

The cumulative incidence of postoperative meningitis was 5% during the 12-month follow-up period. (Table 3). Out of the 46 people with autografts, meningitis was reported in 1 patient (2.17%). On the other hand, 1 of the 14 patients with non-autologous grafts presented with meningitis later (7.14%). Other complications were pseudo meningocele in 5 (8.3%) patients, cerebrospinal fluid (CSF) leak in 3 (5%) patients and reoperation for these complications were done in 3 (5%) patients (Table 4).

(Table 5) The risk of meningitis was 3 times greater in patients with non-autologous grafts than autologous grafts (RR = 3.29). The risk, however, was about the same in both genders (RR = 0.33) and urban and rural residents (RR = 0.76). There was a slightly higher risk in patients with neurological deficits both sensory and motor (RR = 1.73). People with headaches showed no trend (RR = 0.76), while patients with neck pain had a slightly greater risk (RR = 1.73). Lower and middle socioeconomic status recorded a higher risk as compared to the upper class as both cases were recorded in these classes. In other outcomes, pseudo meningocele was twice as prevalent in non-autologous grafts (RR = 2.20), meanwhile CSF leak and reoperation was slightly higher in non-autologous grafts (RR = 1.64 for both)

Fisher's exact test and chi-square analysis did not demonstrate any statistically significant associations between postoperative meningitis and demographic, clinical, or surgical variables ($p > 0.05$ for all comparisons), although trends toward higher risk were observed in patients with non-autologous grafts, lower socioeconomic status, and those with more severe clinical presentation. Lack of significant associations was because of the small number of events and small sample size.

**Table 1 Demographic profile of patients**

| Demographic profile | | N | % |
|---|---|---|---|
| Gender | Male | 15 | 25.0% |
| | Female | 45 | 75.0% |
| Socioeconomic background | Low | 13 | 21.7% |

| | | | |
|---|---|---|---|
| | Middle | 25 | 41.7% |
| | High | 22 | 36.7% |
| Residence | Rural | 26 | 43.3% |
| | Urban | 34 | 56.7% |

**Table 2 Presenting symptoms**

| Presenting symptoms | | Number of patients | Percentage of patients |
|---|---|---|---|
| Headache | Yes | 34 | 56.7% |
| | No | 26 | 43.3% |
| Neck pain | Yes | 22 | 36.7% |
| | No | 38 | 63.3% |
| Sensory/Motor deficit | Yes | 22 | 36.7% |
| | No | 38 | 63.3% |

**Figure 1 Duraplasty graft types**

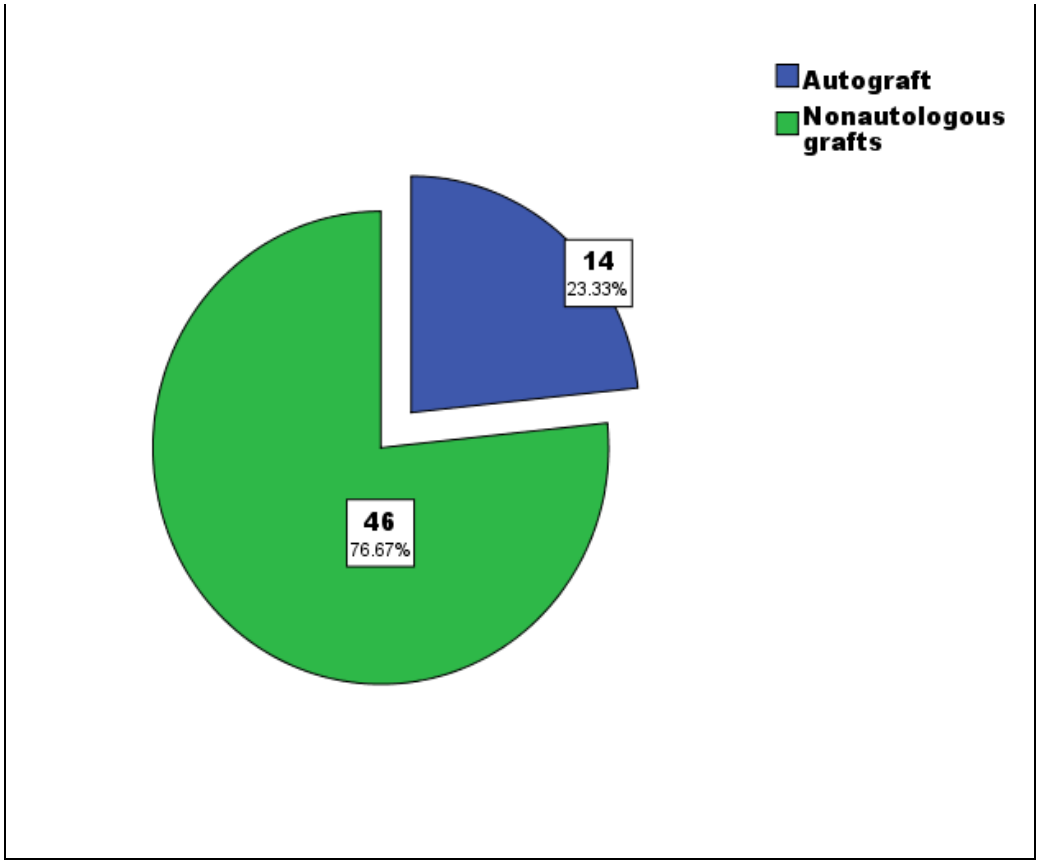

**Table 3 Incidence of meningitis**

| Meningitis | Number of patients | Percentage of patients |
|---|---|---|
| Yes | 3 | 5% |
| No | 57 | 95% |

**Table 4 Other complications**

| Other complications | | Number of patients | Percentage of patients |
|---|---|---|---|
| Pseudo meningocele | Yes | 5 | 8.3% |
| | No | 55 | 91.7% |
| CSF leak | Yes | 3 | 5.0% |
| | No | 57 | 95.0% |
| Reoperation | Yes | 3 | 5.0% |
| | No | 57 | 95.0% |

**Table 5 Calculation of Relative Risks**

| **Outcome** | **Comparison (exposure vs reference)** | **Risk in exposed** | **Risk in reference** | **Relative Risk (RR)** |
|---|---|---|---|---|
| **Meningitis** | Non-autologous vs Autograft | 7.14% | 2.17% | 3.29 |
| | Female vs Male | 2.22% | 6.67% | 0.33 |
| | Urban vs Rural | 2.94% | 3.85% | 0.76 |
| | SES Lower vs Upper | 7.69% | 0% | - |
| | SES Middle vs Upper | 4% | 0% | - |
| | Neurological Deficits (Both sensory and motor) Present vs Absent | 4.55% | 2.63% | 1.73 |
| | Headache Yes vs No | 2.94% | 3.85% | 0.76 |
| | Neck Pain Yes vs No | 4.55% | 2.63% | 1.73 |
| **Pseudo meningocele** | Non-autologous vs Autograft | 14.3% | 6.5% | 2.20 |
| **CSF Leak** | Non-autologous vs Autograft | 7.1% | 4.3% | 1.64 |
| **Reoperation** | Non-autologous vs Autograft | 7.1% | 4.3% | 1.64 |

**DISCUSSION:**

This prospective cohort study assessed the risk of meningitis and the other postoperative complications following posterior fossa decompression in patients with Chiari malformation type 1 and syringomyelia. The most frequent postoperative complication was found to be pseudo meningocele followed by meningitis, CSF leak, and reoperation. No significant associations were found for the post-operative complications with any of the demographic, clinical or surgical variables including graft types.

The overall incidence of meningitis of this study (5%) was higher than some international studies, with De Vlieger et all [18] quoting the incidence to be 2.0% in 105 patients including the ones with and without syringomyelia. However, it was much smaller than other studies with Pan et all [19] documenting an overall meningitis rate in 55 patients to be 7.3%. This rate was also higher than the only local study with Khan et all reporting 1.9% but that was in 24 patients with PFD without duraplasty. It was 0% in 28 patients who also underwent duraplasty. [20] This study also found a 3 times greater risk of meningitis in patients who received non-autologous grafts as compared to autologous, but no significant association which is like the result of Jabarah et all which describes an insignificant heterogenicity (P value = 0.97) for 1% meningitis with autologous grafts compared to 2.17% in our study. [21] This research has an overall rate of meningitis in non-autologous grafts as 7.14% which is also in accordance with Jabarah et all quoting significant heterogenicity (P value = 0.01) in 5% patients of meningitis with synthetic grafts, significant heterogenicity (P value = 0.06) in 8% patients of meningitis with xeno grafts but insignificant heterogenicity (P value = 0.24) in 2% patients of meningitis with allografts. [21] These results are also confirmed by Chai et all. [22]

No studies, abroad or local were found in the literature which compared post-operative meningitis rates according to the gender and socioeconomic status. Our study hints that both demographics are insignificant. There was no evidence found in the literature which compares post-operative meningitis with pre-operative neurological deficits and symptoms like headache and neck pain, so they can be used as predictors of meningitis. Our study is suggestive of a trend between post-operative meningitis and neurological deficits as well as neck pain but, no such trend was observed in patients with pre-operative headaches.

As for the other complications, pseudo meningocele was higher in this study (8.3%) than Yahanda et all, [23] who reported it as 5.2%. The rate of pseudo meningocele in autografts patients was significantly higher in this study (6.5%) compared to 0.4% in Yahanda et all. [23] Meanwhile the rate of the complication in patients with non-autologous grafts was similar, 14.3% vs 6.5-11.6% (for different non-autologous grafts) as reported by Yahanda et all. [23] CSF leak meanwhile was slightly higher in this study (5%) than international studies like De Vlieger et all [18] which outlined it as 4% and Yahanda et all [23] narrating it as 3.6%, but lower than national studies like Rehman et all [24] communicating it as 9.25%. The risk of CSF leak in non-autologous graft patients was slightly higher (RR = 1.64) which is in accordance with Yahanda et all [23] which found it as 3.3% in autografts compared to the 0.4% in synthetic grafts, 4.9% in bovine pericardium, 4.3% in collaged based grafts and 7.6% in allografts, still these CSF leak rates proved to be insignificant for autograft versus non-autologous grafts. The overall rate of reoperation (5%) was slightly higher than De Vlieger et al, [18] which had a rate of 3%. On the other hand, reoperation in autograft patients (4.3%) was analogous to Jabarah et all [21] which had 4% with insignificant heterogenicity. This study found reoperation to be higher in non-autologous graft patients (7.1%) which was also synonymous with Jabarah et all [21] which found it to be 10% in synthetic grafts with insignificant heterogenicity, 9% in allografts and 5% in xenografts with insignificant heterogenicity.

This study has several limitations that have to be acknowledged. Firstly, the small sample size (n = 60) and the small number of meningitis patients limit the statistical power of the study, which may also explain the lack of significant associations despite observed trends. Secondly, since it is a single center study, the results may have low generalizability to other clinical settings with different surgical expertise, patient populations, or healthcare resources. Thirdly, although efforts were made to control confounding variables, residual confounding cannot be entirely excluded, particularly with respect to intraoperative factors such as surgical technique variations and surgeon experience. Additionally, the non-randomized allocation of graft types introduces potential selection bias, as the choice of graft material was based on intraoperative judgment rather than standardized criteria. Furthermore, the follow-up duration of 12 months, while being adequate for early post-operative complications, might have failed to capture late-onset infections or long-term outcomes and complications pertaining to the use of the related graft materials. Lastly, microbiological characterization of meningitis cases, along with the differentiation between bacterial and aseptic meningitis, were not explored which could have provided a deeper insight into the underlying etiology of the infections.

**CONCLUSION:**

Posterior fossa decompression with duraplasty is an effective surgical intervention for Chiari malformation Type 1 with syringomyelia but is associated with a measurable risk of post-operative complications. This study found a 5% incidence of meningitis, along with a notable rate of pseudo-meningocele, CSF fluid leak and reoperation. No statistically significant associations were identified between meningitis and demographic, clinical or surgical variables, however a trend towards increased risk with non-autologous grafts and a more severe clinical presentation was observed. These findings have

highlighted the fact that meticulous surgical techniques, careful selection of dural graft materials and vigilant post-operative monitoring. Further large-scale, multicenter studies are warranted to better define risk factors and optimize surgical strategies to minimize complications and improve patient outcomes

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