

# Long-Term Outcomes of Cerebrospinal Fluid Leak Management in Paediatric Posterior Fossa Surgery

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## ABSTRACT

**Objectives:** 1). To evaluate the long-term outcomes of CSF leak management in paediatric posterior fossa surgeries and to identify the effectiveness of various management strategies and their relationship with surgery types.

**Methodology:** A retrospective study was conducted from January 2023 to December 2023, involving 150 paediatric patients who underwent posterior fossa surgeries. Data on patient demographics, surgery type, CSF leak management strategies, and postoperative outcomes were collected from medical records. Statistical analysis included descriptive statistics and chi-square tests. Data were analysed using SPSS version 22.

**Results:** The mean age of the patients was  $10.2 \pm 5.1$  years, with 51% males and 49% females. The most common management strategies were lumbar drainage (37%) and duraplasty (28%). Tumour resections more frequently required revision surgery (24%) compared to Chiari malformation decompressions. A significant statistical association ( $p = 0.0286$ ) was observed between surgery type and CSF leak management strategy. Outcomes showed that lumbar drainage had a higher incidence of recurrence (15%) and pseudomeningoceles (5%) compared to duraplasty, which had a 90% success rate in resolving CSF leaks.

**Conclusion:** Lumbar drainage and duraplasty are effective methods for managing CSF leaks in paediatric posterior fossa surgeries. Tailored management strategies based on surgery type are crucial for improving outcomes. The study provides local insights into CSF leak management in Pakistan and highlights the need for further research, including prospective and multicentre studies.

**Keywords:** Cerebrospinal fluid leak, Cranial fossa, Foass postrea CSF leak, Paediatric, Posterior fossa

### Authors' Contribution:

<sup>1,2</sup>Conception; Literature research; manuscript design and drafting; <sup>2,3</sup>Critical analysis and manuscript review; <sup>1,3</sup>Data analysis; Manuscript Editing.

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## Introduction

The management of Cerebrospinal Fluid (CSF) leaks, particularly after paediatric posterior fossa surgeries, is a critical area of focus in neurosurgery. These leaks pose significant risks for both short-term and long-term outcomes, contributing to complications such as pseudomeningoceles, wound infections, and neurological deficits.<sup>1</sup> Paediatric posterior fossa surgeries, frequently performed for

tumours or Chiari malformation, are associated with increased vulnerability to CSF leakage due to the complex anatomy and close proximity to vital structures.<sup>2</sup> The long-term management of these leaks has become an area of increasing concern, particularly when considering the complications and the associated risk of secondary issues such as hydrocephalus and delayed rehabilitation.<sup>3</sup> CSF leaks after posterior fossa surgery are primarily

caused by dural defects or inappropriate closure of the Dura mater after tumour resections or decompressed surgeries.<sup>4</sup>

When these defects occur in the paediatric population, particularly following resection of posterior fossa tumours such as medulloblastomas or pilocytic astrocytoma's, the challenge of maintaining CSF integrity becomes paramount.<sup>5</sup> In the context of a growing body of literature, various methods of managing CSF leaks have been explored, including the use of lumbar drains, dural grafts, and other adjunct therapies. Each approach varies in effectiveness, particularly in terms of reducing the rates of long-term complications.<sup>6</sup>

Recent studies have demonstrated the importance of early intervention in managing CSF leaks to prevent long-term complications. For example, the use of lumbar drains has been found to significantly reduce the rates of CSF leakage in the postoperative period, particularly when utilized selectively in high-risk cases.<sup>7</sup> However, there is still considerable debate regarding the best management protocols, with some studies suggesting that duraplasty and grafting procedures may offer better results in terms of reducing CSF leaks, but with an increased risk of pseudomeningoceles formation.<sup>1</sup> As a result, this topic remains an active area of investigation, especially in the context of paediatric patients who face the long-term consequences of surgical management.

In Pakistan, the rate of CSF leaks following posterior fossa surgeries remains an important issue, with a notable lack of comprehensive data from local studies. In one local study conducted at Khyber Teaching Hospital, Peshawar, postoperative complications such as CSF leaks were highlighted as a significant concern, with particular emphasis on the challenge of managing these issues in paediatric patients.<sup>8</sup> This underscores the need for a targeted approach to the prevention and management of CSF leaks in paediatric neurosurgery, particularly in tertiary care centres such as Hayatabad Medical

Complex, Peshawar, where a large number of paediatric neurosurgical procedures are carried out. The long-term outcomes of paediatric posterior fossa surgery are further complicated by the need for subsequent interventions to address complications such as hydrocephalus, which is frequently observed after these surgeries.<sup>9</sup> In some cases, hydrocephalus management has been shown to delay the initiation of adjuvant therapies such as radiotherapy, which can negatively impact survival and quality of life.<sup>2</sup> Such delays can be critical, particularly in tumours like medulloblastomas, where time to treatment is an important determinant of prognosis. Thus, understanding the long-term effects of CSF leaks and their management is crucial not only for preventing immediate postoperative complications but also for optimizing long-term survival and quality of life in these patients.

Additionally, the utilization of advanced surgical techniques, such as endoscopic endonasal approaches for skull base tumours, has shown promise in reducing CSF leakage, although its applicability in paediatric cases remains limited.<sup>10</sup> Moreover, technological advancements in CSF diversion techniques and postoperative monitoring continue to evolve, suggesting that the management of CSF leaks may become more efficient and patient-friendly in the future.

The rationale for this study stems from the observed gaps in our understanding of the long-term outcomes of CSF leak management in paediatric posterior fossa surgeries, particularly in the local context. While international studies have provided valuable insights, there is a need to examine how these findings can be applied within Pakistani healthcare settings, particularly at the Hayatabad Medical Complex, Peshawar. Moreover, understanding the long-term outcomes will guide clinicians in optimizing care pathways for paediatric patients undergoing these surgeries.

The objective of this study was to evaluate the long-term outcomes of CSF leak management in

paediatric posterior fossa surgeries at Hayatabad Medical Complex, Peshawar, and to develop an effective strategy for minimizing complications associated with these procedures.

## Methodology

This retrospective study conducted at the Department of Neurosurgery, Hayatabad Medical Complex, Peshawar, from January 2023 to December 2023. The study aimed to evaluate the long-term outcomes of CSF leak management in paediatric posterior fossa surgeries. The setting is a well-established tertiary care centre in Peshawar, providing care for a significant number of paediatric neurosurgical cases annually.

### Sample Size

The sample size for this study was determined using the WHO sample size calculator. Based on a previous study, where CSF leak rates in paediatric posterior fossa surgeries were approximately 15%, a sample size of 150 patients was calculated to achieve a 95% confidence level and a 5% margin of error.<sup>5</sup> The study included 150 paediatric patients who underwent posterior fossa surgery during the study period, with CSF leak management as the primary focus. This sample size was considered adequate to ensure robust results with statistical significance.

**Inclusion Criteria:** Paediatric patients aged between 1 and 18 years who underwent posterior fossa surgery were included.

### Exclusion criteria included:

- (1) Patients with previous neurological conditions that might interfere with the results, such as hydrocephalus from non-surgical causes;
- (2) Those who were lost to follow-up;
- (3) Patients who underwent surgical procedures unrelated to posterior fossa pathology.

Data for this study were collected from the hospital's electronic medical records (EMR) system. The following variables were extracted: (1) demographic information (age, gender); (2) type of posterior fossa surgery (e.g., tumour resection, Chiari malformation

decompression); (3) intraoperative and postoperative complications, particularly CSF leaks; (4) details of CSF leak management (e.g., lumbar drainage, duraplasty, additional surgeries); (5) outcomes related to the CSF leak (e.g., resolution, recurrence, pseudomeningoceles formation); and (6) the duration of follow-up. All data collection was carried out by the research team under the supervision of the principal investigator to ensure consistency and accuracy.

### Definitions and Assessment Criteria

For the purposes of this study, the following definitions were used: CSF leak was defined as the presence of CSF escaping from the surgical site postoperatively, confirmed either by clinical symptoms (such as clear fluid drainage) or imaging studies (e.g., CT or MRI). The success of CSF leak management was assessed based on the resolution of the leak, recurrence rate, and the development of pseudomeningoceles or other complications such as wound infections. Postoperative complications such as infections, the need for revision surgeries, and neurological deficits were also noted.

The data were analysed using SPSS version 22. Descriptive statistics were used to summarize demographic data and outcomes. Chi-square test was used to compare the rates of CSF leak and management methods between different groups (e.g., age groups, type of surgery). A p-value of <0.05 was considered statistically significant.

**Ethical approval** for this study was obtained from the Ethical and Research Committee (Ref#1269 dated 16<sup>th</sup> November, 2023).

## Results

A total of 150 paediatric patients were included in the study, all of whom underwent posterior fossa surgery at Hayatabad Medical Complex, Peshawar, between January 2023 and December 2023.

The mean age of the patients was  $10.2 \pm 5.1$  years, with an age range from 1 to 18 years.

Sex	Count	Mean Age ± SD (Years)
Male	77 (51%)	
Female	73 (49%)	
Age		10.2 ± 5.1

In total 77 (51%) were male and 73(49%) were female The demographic details are presented in Table I.

The distribution of CSF leak management strategies is shown in Table 2. The most commonly used management technique was lumbar drainage. The type of surgery significantly influenced the CSF leak management approach. Chiari malformation decompression procedures were more commonly managed with lumbar drainage, while tumour resection cases were more likely to involve revision surgery. A chi-square test revealed a statistically significant association between surgery type and CSF leak management strategies ( $p = 0.0286$ ).

The statistical analysis revealed a significant association between the type of surgery and the CSF leak management strategy ( $p = 0.0286$ ). Based on the data, Chiari malformation decompression surgeries were more commonly managed with lumbar drainage (32.88%) compared to tumour resection surgeries, which had a higher incidence of revision surgery (31.17%).

The postoperative outcomes related to CSF leak management were assessed, with a focus on the resolution of leaks, recurrence, and the development of pseudomeningoceles. The patients who received lumbar drainage, the CSF leak resolved in 80% of cases, while 15% experienced recurrence, and 5% developed pseudomeningoceles. In contrast, those who underwent duraplasty showed a higher rate of resolution (90%) and a lower recurrence rate (5%). The analysis of outcomes based on management strategy showed that lumbar drainage was associated with a higher incidence of CSF leak recurrence and pseudomeningoceles formation compared to duraplasty. This underscores the importance of selecting an appropriate

Surgery Type	Duraplasty	Lumbar Drain	No Intervention	Revision Surgery
Chiari malformation decompression	21 (28.77%)	24 (32.88%)	18 (24.66%)	10 (13.70%)
Tumour resection	23 (29.87%)	13 (16.88%)	17 (22.08%)	24 (31.17%)

management strategy based on the type of surgery and the specific needs of the patient.

## Discussion

The results of this study highlight several key findings regarding the management of CSF leaks following paediatric posterior fossa surgeries. The most common management strategies included lumbar drainage (37%), followed by duraplasty (28%), with revision surgery being more frequently employed in tumour resection cases. A statistically significant association was observed between surgery type and CSF leak management, with Chiari malformation decompression surgeries more often treated with lumbar drainage, while tumour resections leaned towards revision surgery ( $p$ -value = 0.0286). The demographic characteristics of the study cohort included an equal sex ratio, with 77 male patients (51%) and 73 female patients (49%), and an average age of 10.2 ± 5.1 years.

This study provides novel insights into the management of CSF leaks following posterior fossa surgeries in paediatric patients, particularly in the context of a tertiary care centre in Pakistan. While CSF leaks following posterior fossa surgeries have been extensively studied globally, the majority of research has been conducted in Western countries. Studies in Pakistan discuss management protocols, but this study expands upon their work by focusing on a more specific paediatric population and providing statistical comparisons between various management strategies.<sup>11,12</sup>

International studies on CSF leaks, have similarly noted that the choice of CSF leak management is influenced by surgery type, with some favouring

lumbar drainage and others advocating for more invasive interventions like duraplasty or revision surgery.<sup>13,14</sup> In these studies, lumbar drainage is commonly used for the management of postoperative CSF leaks, as confirmed in our findings.

In countries such as the United States and China, studies have evaluated the outcomes of CSF leak management in posterior fossa surgeries. For instance, a study conducted on CSF leaks following posterior fossa surgeries, detailing treatment protocols like lumbar drainage and surgical repair.<sup>15</sup> Similarly, a study introduced the concept of a "sandwich" wound closure technique that significantly reduced CSF leaks, a method that could be beneficial for future applications in paediatric populations.<sup>16</sup>

Furthermore, a study reviewed the long-term outcomes of patients with CSF leaks and pseudomeningoceles, showing that repeated surgical interventions are often required when conservative management fails, which aligns with our study's findings that revision surgery is often necessary in some cases of CSF leaks.<sup>15</sup>

Although there is a wealth of international research on CSF leaks following posterior fossa surgeries, studies specifically addressing paediatric patients in Pakistan are limited. This research fills an important gap by focusing on paediatric patients at Hayatabad Medical Complex, Peshawar. Prior studies, have been conducted in Pakistan, but they have not provided a comprehensive, statistical analysis of CSF leak management in paediatric populations specifically.<sup>8,11</sup> Therefore, this study is one of the first in Pakistan to systematically explore the various management strategies and their outcomes, offering valuable local insights. Some studies have been published in Pakistani journals discussing CSF leak management, particularly in adult populations. A study in the *Pakistan Journal of Medical Sciences* found that re-suturing combined with lumbar drainage was the most effective approach for managing incisional CSF leaks in posterior fossa

surgeries.<sup>11</sup> Our study corroborates these findings by demonstrating the efficacy of lumbar drainage in paediatric cases as well. Additionally, a study in Khyber Teaching Hospital, Peshawar, highlighted CSF leak complications in posterior fossa surgeries, which further emphasizes the relevance of our study to local clinical practices.<sup>8</sup>

This study has contributed significant data to the existing knowledge on CSF leak management in paediatric posterior fossa surgeries. By exploring the role of different management strategies, such as lumbar drainage and revision surgery, it expands upon previous work that primarily focused on adult populations. The statistical significance of surgery type influencing CSF leak management adds a new dimension to existing research. The critical review of literature reveals a growing consensus on the importance of early intervention and tailored management strategies to prevent long-term complications, such as pseudomeningoceles and infections.

The findings of this study are consistent with international literature that emphasizes the need for individualized management of CSF leaks, based on factors such as the type of surgery and patient characteristics. Our results further suggest that while lumbar drainage is an effective and commonly used method, more invasive interventions, such as revision surgery, are necessary in certain cases. The statistically significant association between surgery type and management strategy reinforces the importance of personalized care in paediatric neurosurgery.

#### **Study Limitations and Future Directions**

One of the main limitations of this study is its retrospective design, which relies on existing medical records. This approach may be subject to biases such as incomplete data or misclassification of outcomes. Moreover, the study was conducted at a single tertiary care centre, which may limit the generalizability of the findings to other healthcare settings in Pakistan. Multicenter studies should be conducted to enhance the authenticity of the

results. Furthermore, a prospective cohort study would allow for more accurate and controlled data collection, reducing the risk of bias.

The findings align with international research and offer valuable information for clinical practice in Pakistan.

## Conclusion

The study highlights the importance of personalized care in managing CSF leaks following posterior fossa surgeries. Lumbar drainage and duraplasty are effective strategies, while revision surgery may be necessary in certain cases. Incorporating quality of life assessments and exploring advanced management techniques such as dural sealants could further enhance outcomes for paediatric patients undergoing these surgeries.

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