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*Original Research Article*

# Common Cerebrospinal Fluid (CSF) Leakage in Patients Undergoing Tethered Cord Syndrome (TCS) and Myelomeningocele Repair

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***Abstract***: ***Background:*** Postoperative cerebrospinal fluid leakage is a common, postoperative complication after surgery on forms of congenital spinal anomalies and especially myelomeningocele and tethered cord syndrome. Even after the surgical technique improved, the CSF leakage remains one of the factors that lead to wound morbidity, prolonged hospitalization, and re-intervention. There is a dearth of local statistics on its prevalence and the risk factors in pediatric populations. ***Methodology:*** This analytical study was an observational study involving the use of 72 children to undergo surgical repair of myelomeningocele or tethered cord syndrome at Khyber teaching hospital Peshawar. Sampling was done consecutively among patients within a period of one year. Demographic, clinical, and operative data were taken. CSF leakage after the operation and other complications associated with the wound were recorded and correlation between leakage and the possible risk factors was performed using the involved statistical tests. ***Results***: CSF leakage was present in 14 patients and this was postoperative (19.4%). In children with myelomeningocele, hydrocephalus and ventriculoperitoneal shunts, the number of cases with leakage was a lot more. Weakness of the skin on top of the lesion, patch dural closure, and no use of fibrin sealant were also risk factors. Patients with developed CSF leakage had prolonged stay in hospitals as well as high chances of having to be re-explored. ***Conclusion:*** Postoperative CSF leakage remains a considerable source of morbidity following repair of congenital spinal anomalies. Identification of high-risk patients and reinforcement of dural closure techniques may help reduce the incidence of this complication.

*Keywords*: Cerebrospinal fluid leakage, Myelomeningocele, Tethered cord syndrome, Pediatric neurosurgery, Dural closure, Wound complications

## INTRODUCTION

Spinal cord congenital anomalies especially myelomeningocele and tethered cord syndrome are a significant cause of neurological disability among

children. Such cases usually necessitate the early interventions by surgery to avoid the progressive neurological decline, better functional prognosis and decreased risk of infection. Despite surgical repair becoming standard in most facilities, the consequences caused by wounds after surgery still affect the recovery and the outcome over the long term (1-3).

Out of these complications, cerebrospinal fluid leakage is one of the most difficult. Recurrent leakage of CSF may result in dehiscence of the wound, the development of a pseudomeningocele, meningitis as well as long hospital stay. Such complications are usually difficult to manage, and this necessitates further surgical interventions, which add emotional and financial heavy burden to the families (4-6).

The past research has proposed that the predisposing factors may include hydrocephalus, shunt between the ventricles and the peritoneum, the size of the defect, and the condition of the skin (7, 8). Nonetheless, the differences in population of patients, surgical procedures, and medical facilities restrict the applicability of the research results. This research was thus aimed at establishing the incidence of postoperative CSF leakage and its risk factors among children who had surgical repair of myelomeningocele and tethered cord syndrome in a tertiary care facility.

## MATERIAL AND METHODS

This observational analytic research was carried out in the Department of Neurosurgery, Khyber Teaching Hospital Peshawar, during a span of twelve months from May 2024 to May 2025. The objective of the study was the children who had undergone surgical intervention such as the correction of myelomeningocele or tethered cord syndrome during the specified study period. Ethical approval of the institution was received before the start of the data collection process and all the processes were carried out in accordance to accepted ethical standards. Informed consent was obtained in writing among the parents or legal guardians of the all participants.

There were 72 respondents comprising pediatric patients who were sampled on a consecutive method. All the children who have myelomeningocele or tethered cord syndrome and their surgical repair that is planned to be done are all eligible. Patients who had prior spinal surgery or had incomplete medical records as well as those referred following a postoperative complication in a different area were eliminated to ensure uniformity of data. This sample type was used because it has an opportunity to include all the eligible patients who arrived within the research period, which would minimize the selection bias.

Medical records provided clinical information and assessment of the patients at admission directly. Demographic information of the patients in terms of age, sex, residential background, mode of delivery and antenatal diagnosis were taken. The preoperative variables were the degree of the spinal lesion, neurological status, hydrocephalus, ventriculoperitoneal shunt and skin condition above the lesion. Standardized case record forms were used to record the operational details such as the nature of the procedure, dural closure method, grafts and sealants used as well as the duration that the operation took.

Each of the procedures was under general anesthesia and in compliance with the standard sterile procedures. Proper dissection was done in myelomeningocele cases, whereby neural tissue was preserved and excision of nonviable elements was done to completion and watertight dural closure was obtained. In tethered cord release, the dural sac and the spinal cord were carefully detethered and replaced. Primary dural repair was also to be done in all the patients though patch grafting was done wherever direct approximation was not possible. In all cases, soft tissue layered closure was done to reduce dead space.

During the postoperative period, patients were observed closely due to the signs of cerebrospinal fluid leakage, complications to the wound, and neurological alterations. Daily wound assessment was carried out during the stay in the hospital and two weeks, one month and three months post-operative follow-up visits were arranged. The definition of CSF leakage was given as constant clear fluid leakage of the wound or the appearance of pseudomeningocele which was clinically verified. The duration of stay in the hospital and re-intervention were also noted.

The main outcome measure was the postoperative cerebrospinal fluid leakage. The secondary outcomes were wound infection, development of pseudomeningocele, meningitis, surgical re-exploration necessity and length of stay. Functional outcomes were measured based on the changes in the motor and bladder-bowel functions in the follow-up visits.

Statistical programs were used to input and analyze the data. Continuous variables were summarized in terms of means and standard deviations, whereas categorical variables were in terms of frequencies and percentages. The chi-square test was used to test associations between postoperative CSF leakage and the risk factors that could be present. A p-value of 0.05 was taken as being statistically significan

## RESULTS

The participants in the study consisted of 72 children who went through the emergency room and were undergoing surgery on either myelomeningocele or tethered cord syndrome. The majority of patients were below the age of one year which means early surgical referral of neural tube defects. The number of males was marginally higher than that of females and almost an equal number was selected both in the urban and rural regions.

**Table 1: Demographic Characteristics of Study Population (n = 72)**

| Variable | Category | n (%) |
|---|---|---|
| Age (years) | Mean ± SD | 2.9 ± 2.4 |
| | ≤1 year | 32 (44.4) |
| | 1–5 years | 27 (37.5) |
| | >5 years | 13 (18.1) |
| Gender | Male | 41 (56.9) |
| | Female | 31 (43.1) |
| Residence | Urban | 38 (52.8) |
| | Rural | 34 (47.2) |
| Mode of delivery | Normal vaginal | 44 (61.1) |
| | Cesarean section | 28 (38.9) |
| Antenatal diagnosis | Yes | 29 (40.3) |
| | No | 43 (59.7) |

Almost all the cases were myelomeningocele, which is the most common indication of surgery. The most frequent level of lesion was Lumbosacral and closely after it there were lumbar lesions. Nearly fifty percent of the patients had related hydrocephalus, and more than fifty percent had preoperative neurological deficits.

**Table 2: Preoperative Clinical Characteristics**

| Variable | Category | n (%) |
|---|---|---|
| Diagnosis | Myelomeningocele | 46 (63.9) |
| | Tethered cord syndrome | 26 (36.1) |
| Lesion level | Lumbar | 29 (40.3) |
| | Lumbosacral | 31 (43.1) |
| | Sacral | 12 (16.6) |
| Hydrocephalus | Present | 34 (47.2) |
| VP shunt in situ | Yes | 21 (29.2) |
| Pre-op neurological deficit | Present | 39 (54.2) |
| Skin ulceration over lesion | Yes | 17 (23.6) |

Superior dural closure was obtained in slightly more than fifty percent of the cases and the rest of the patients needed patch grafting. It was found that the fibrin sealant was administered in over a third of the surgeries and in most cases, layered wound closure was done. The average duration of operation was less than two hours indicating comparatively standardized surgical procedures.

**Table 3: Operative Details**

| Variable | Category | n (%) |
|---|---|---|
| Type of procedure | MMC repair | 46 (63.9) |
| | TCS detethering | 26 (36.1) |
| Dural closure | Primary | 41 (56.9) |
| | Patch graft | 31 (43.1) |
| Fibrin glue used | Yes | 27 (37.5) |
| Layered wound closure | Yes | 60 (83.3) |
| Mean operating time | Minutes (Mean ± SD) | 96 ± 18 |

Cerebrospinal fluid leakage was felt in almost one-fifth of the patients involved during the study. The most common associated complications were surgical site infections, and formation of pseudomeningocele. Only a minor percentage needed to be re-explored but the length of hospital stay was mostly one week among the majority of patients.

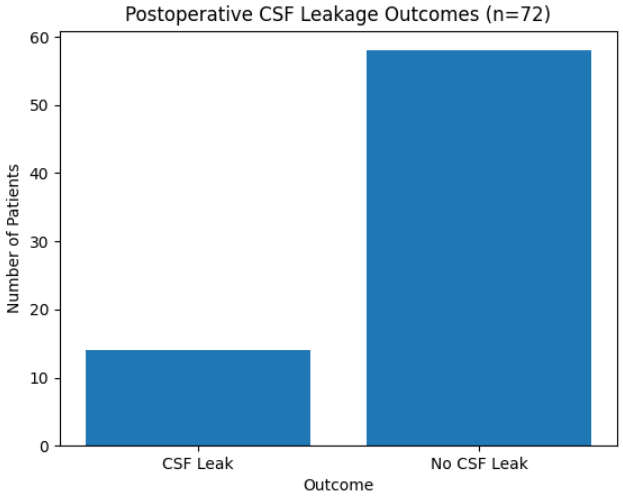
**Table 4: Postoperative Outcomes**

| Outcome | Category | n (%) |
|---|---|---|
| CSF leakage | Yes | 14 (19.4) |
| Wound infection | Yes | 11 (15.3) |
| Pseudomeningocele | Yes | 8 (11.1) |
| Meningitis | Yes | 5 (6.9) |
| Re-exploration required | Yes | 6 (8.3) |
| Mean hospital stay | Days (Mean ± SD) | 7.8 ± 2.3 |

The postoperative CSF leakage was much more prevalent in patients with myelomeningocele than in those with tethered cord syndrome. Postoperative leakage was also strongly related to the existence of hydrocephalus and pre-existing VP shunt. The risk of this complication was also enhanced by poor skin state and lack of using fibrin glue.

**Table 5: Factors Associated With CSF Leakage**

| Variable | CSF Leak Present (n=14) | No Leak (n=58) | p-value |
|---|---|---|---|
| MMC diagnosis | 11 | 35 | 0.042 |
| Hydrocephalus | 10 | 24 | 0.018 |
| VP shunt | 8 | 13 | 0.009 |
| Patch dural closure | 9 | 22 | 0.031 |
| Skin ulceration | 7 | 10 | 0.006 |
| Fibrin glue not used | 11 | 34 | 0.021 |




**Distribution of postoperative cerebrospinal fluid (CSF) leakage among the study population (n = 72).** The figure shows the number of patients who developed postoperative CSF leakage compared with those who did not following

surgical repair for myelomeningocele and tethered cord syndrome

## DISCUSSION

Cerebral spinal fluid leakage post surgery is one of the most common and problematic postoperative complications in relation to myelomeningocele and tethered cord syndrome surgery. In the current research, the postoperative CSF leaks were observed in almost a quarter of the operated children, which is similar to the indicators of the regional and international pediatric neurosurgical series. Previous reports of South Asia and Middle East have reported CSF leak rates of 12 to 25% after comparable surgeries, and thus it means that in spite of improved microsurgical procedures, this complication remains a clinical challenge. These findings are consistent and can indicate that other patient and disease-related variables can be even more significant than the operative technique itself (9-11).

It was also found that myelomeningocele was significantly linked with CSF leakage in the postoperative period as compared to tethered cord syndrome. The given observation is consistent with the existing literature that indicates that myelomeningocele results in larger neural placide defects and impaired skin coverage which predisposes to wound breakdown and dural inadequacy. Also, children with the hydrocephalus and children with the ventriculoperitoneal shunts recorded were found to exhibit a greater predisposition towards the development of the CSF leakage. This correlation has been characterized in past reports and it is attributed to the high risk due to high intracranial pressure, compromised wound healing, and disturbed CSF mechanics in patients with shunts (12-14).

Patch grafts used in dural closure were also strongly related to postoperative leakage in the current cohort. In spite of the fact that patch grafting frequently has to be applied in situations when primary closure is not possible, it can cause tension or microscopic holes in the suture lines that predispose to the development of CSF seepage. In the same line, patients with skin ulceration over the area before surgery had a significantly high leakage rate, which supports the significance of skin integrity in wound closure. These results underline that the prudent preoperative evaluation and the thorough layered closure are the key elements of the risk mitigation (15-17).

The other interesting finding was that fibrin sealants had protective effect on postoperative CSF leakages. Children whose fibrin glue is absent were prone to the development of leaks which is corroborated by a number of modern series of surgeries that suggest the use of adjunctive sealants to strengthen dural closure (18-20). Though the routine use of such materials may raise the cost of the procedure, the possibility of lowering the re-exploration rates and hospital-stay may explain its selective application, specifically in the high-risk patients.

## CONCLUSION

Postoperative CSF leakage remains a common complication following myelomeningocele and tethered cord syndrome repair. Myelomeningocele, hydrocephalus, ventriculoperitoneal shunting, compromised skin condition, and patch dural closure significantly increase the risk of leakage. Careful patient selection, attention to skin integrity, and reinforcement of dural closure with sealants may help reduce this preventable complication.

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