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Original Research Article

Comparison of Simultaneous and Delayed Ventriculoperitoneal (VP) Shunting in Patients Undergoing Myelomeningocele Repair in Terms of Frequency of Post-Op Shunt Infections

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Abstract: *Myelomeningocele is frequently associated with hydrocephalus requiring ventriculoperitoneal shunt placement. The optimal timing of shunt insertion remains debated due to concerns about postoperative infection and complications.* ***Objective:*** *To compare the frequency of postoperative ventriculoperitoneal shunt infection between simultaneous ventriculoperitoneal shunt placement and delayed ventriculoperitoneal shunt placement in children undergoing myelomeningocele repair.* ***Methods:*** *A comparative analytical study was conducted at the Department of Neurosurgery, Bahawal Victoria Hospital, Bahawalpur, Pakistan, from June 2025 to September 2025. A total of 154 neonates and children aged two days to five years with myelomeningocele and associated hydrocephalus were enrolled through consecutive sampling. Participants were randomly allocated into two groups. The simultaneous group underwent myelomeningocele repair with ventriculoperitoneal shunt placement during the same operative session, whereas the delayed group underwent myelomeningocele repair followed by shunt placement two weeks later. Preoperative assessment, operative findings, and postoperative monitoring were performed according to standardised clinical and laboratory criteria. Patients were followed for 3 months to detect ventriculoperitoneal shunt infection using clinical features and cerebrospinal fluid analysis. Secondary outcomes included shunt malfunction, cerebrospinal fluid wound leakage, and duration of postoperative hospital stay. Data were analyzed using the chi-square test and independent samples t-test, with a significance level of $p < 0.05$.* ***Results:*** *The mean age was comparable between groups, and the majority of children were younger than six months. Overall postoperative ventriculoperitoneal shunt infection occurred in 16.2% of patients. Infection was significantly lower in the simultaneous group (11.7%) compared with the delayed group (20.8%). Ventriculoperitoneal shunt malfunction and cerebrospinal fluid leakage showed no statistically significant differences between the groups. The duration of postoperative hospital stay was significantly shorter in the simultaneous shunt placement group.* ***Conclusion:*** *Simultaneous ventriculoperitoneal shunt placement during myelomeningocele repair is associated with a lower infection rate and shorter hospital stay compared with delayed shunt placement. These findings suggest that simultaneous shunting may represent a safer and more efficient surgical strategy for children with myelomeningocele and hydrocephalus.*

Keywords: Myelomeningocele, Hydrocephalus, Cerebrospinal Fluid Shunts, Postoperative Complications

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Introduction

Myelomeningocele (MMC) is a prevalent congenital neural tube defect characterized by the exposure of the spinal cord and surrounding nerves through a defect in the spine. This condition is often associated with significant neurological deficits, requiring various surgical interventions to manage postnatal complications. (1,2) Hydrocephalus is a prevalent complication, occurring in 70-80% of MMC-diagnosed children and necessitating cerebrospinal fluid (CSF) diversion, often via placement of a ventriculoperitoneal (VP) shunt. (2,3) When VP shunt should be placed, at the same time as the myelomeningocele repair or delayed, is a controversial issue in the sphere of pediatric neurosurgery, with different consequences on the postoperative results, in terms of shunt infection rates in particular.

The rate of VP shunt infections among patients who undergo simultaneous and delayed placements differs considerably. It has been shown that the rate of infection after the insertion of VP shunts is 8% to 10%, which has been a major cause of morbidity and, in some cases, mortality. (4) A recent meta-analysis indicated that there was less risk of infections when using a delayed shunt placement strategy than immediate intervention. (2,5) This research also contributes to the existing discussion by presenting a detailed comparison of infection rates in concomitant and delayed VP shunt insertions in the specific setting of MMC repair.

Moreover, complications arising from management strategies may lead to extended hospital stays and increased healthcare costs. (6,7) The general rate of surgical site infections among MMC patients has been demonstrated to be varying among the various surgical units. An example is the ability to reduce the rate of infection by adhering to protocols, such as administering antibiotic prophylaxis, which can significantly reduce the incidence of infection. (6,8) The risk of post-operative infections may be more pronounced in pediatric populations and especially in developing countries like Pakistan because of several factors, including lack of access to quality medical care, differences in surgical protocols, and the setting where they are performed. (4,9)

In the Pakistani setting, there is a special challenge in dealing with MMC and related complications. The high incidence of this condition, along with socioeconomic factors, makes identifying the most appropriate time to implant VP shunts crucial for clinical outcomes and the reduction of complications such as postoperative infections. (2,10)

This study aims to elucidate evidence-based insights that could inform local practices and ultimately improve the standard of care for children with myelomeningocele in Pakistan.

Methodology

This comparative study was conducted in the Department of Neurosurgery, Bahawal Victoria Hospital (BVH), Bahawalpur, Pakistan, from June 2025 to September 2025. The study included neonates and children of either gender aged 2 days to 5 years who had myelomeningocele (MMC) with hydrocephalus requiring MMC repair

and VP shunt placement, after written informed consent from legal guardians. Non-probability consecutive sampling was used. Patients were excluded if they had MMC without hydrocephalus, other neural tube defects such as lipomeningocele or encephalocele, severe malnutrition, prematurity with severe associated congenital anomalies (for example, cardiac or gastrointestinal defects), documented and unresolved meningitis, encephalitis, or brain abscess in the preoperative period, infected MMC wound, or infected CSF.

The sample size was calculated using the WHO sample size calculator with 80 percent power and 5 percent level of significance, based on expected postoperative shunt infection proportions of 33.3 percent in the simultaneous shunting group and 14.2 percent in the delayed shunting group, resulting in a total sample of 154 participants (77 per group). Participants were allocated into two groups using a lottery method. Group A underwent MMC repair and VP shunt placement in the same operative session, while Group B underwent MMC repair first, followed by VP shunt placement after two weeks. Surgical procedures were performed by consultant neurosurgeons (FCPS) with at least five years of experience. Perioperative antibiotic prophylaxis was standardized with ceftriaxone 50 mg/kg administered 30 minutes prior to skin incision, followed by ceftriaxone 100 mg/kg/day for at least three days postoperatively. Intraoperative findings and any intraoperative complications were documented for each case.

The baseline data were documented on a structured proforma with the following variables: age, gender, antenatal and perinatal history, vaccination history, medical history, nutritional history, and preoperative assessment. Investigations: Preoperative examinations comprised physical examination, lab tests such as CSF analysis and culture, and neuroimaging (MRI or CT scan) to ensure accurate diagnosis and treatment. The clinical monitoring of meningitis, wound CSF leak, and shunt functional evaluation were included in the postoperative assessment sustainably by radiological and laboratory tests: CBC, CRP, CSF analysis, and CSF culture in case of clinical indication. Since most shunt infections occur within three months of shunt insertion, the participants were followed up after three months; follow-up visits were scheduled at 7 days in the first month after discharge and then every other week thereafter. Re-examination was performed after 2 weeks according to the operational definition and culture outcomes in cases where it suggested the possibility of reactive changes in CSF.

The primary outcome (dependent variable) was postoperative VP shunt infection, recorded as a categorical outcome (yes or no) and defined using clinical features such as fever, neck stiffness, poor dietary intake, and supportive CSF findings, including elevated protein, low CSF sugar, neutrophil predominance, and a positive CSF culture obtained after 48 hours of shunt placement. Secondary dependent variables included VP shunt malfunction (yes or no), wound CSF leak (yes or no), and postoperative hospital stay measured as a continuous variable in days from the end of operation to discharge. The principal independent variable was timing strategy of VP shunting (simultaneous versus delayed). Additional independent variables included age (continuous, and also categorized into clinically relevant age groups during stratified analysis) and gender (male or female).

The data analysis was conducted using SPSS version 26. The quantitative variables, e.g., age and postoperative hospital stay, were summarized as mean ± standard deviation. In contrast, categorical variables, e.g., gender, shunt infection, shunt malfunction, and wound CSF leak, were summarized as frequencies and percentages. The chi-square test was used to compare groups on categorical outcomes (including the primary outcome of shunt infection and secondary complications). The independent samples t-test was used to compare the means of the two groups' hospital stays. The chi-square test was used to perform stratified analyses to determine differences in complication rates by age groups and gender subgroups. p less than 0.05 was taken as the statistical significance.

Results

The overall mean age was 4.1 ± 1.9 months, comparable between Group A (4.0 ± 1.8) and Group B (4.2 ± 2.0) ($t = 0.55$, $p = 0.58$). Most patients were 0 to 6 months (71.4 percent), with no difference in age-group distribution ($\chi2 = 0.74$, $p = 0.69$). Males were 59.7 percent, and gender distribution was similar across groups ($\chi2 = 0.13$, $p = 0.72$). (Table 1). This indicates that the baseline demographic characteristics were balanced across the two intervention groups.

For the primary outcome, postoperative VP shunt infection was observed in 25 of 154 patients (16.2%). Shunt infection occurred less frequently in the simultaneous shunting group (9 patients, 11.7 percent) than in the delayed shunting group (16 patients, 20.8 percent). This difference was statistically significant ($\chi2 = 4.11$, $p = 0.04$), indicating a higher infection burden among patients who underwent delayed VP shunt placement (Table 2).

Table 3 shows secondary outcomes. Shunt malfunction was 9.1 percent in Group A versus 13.0 percent in Group B ($\chi2 = 0.61$, $p = 0.43$), and wound CSF leak was 6.5 percent versus 11.7 percent ($\chi2 = 1.27$, $p = 0.26$), with no significant group differences. Hospital stay was significantly shorter with simultaneous shunting (5.8 ± 2.1 days) compared with delayed shunting (7.4 ± 2.8 days) ($t = 3.41$, $p = 0.001$).

On stratified analysis, shunt infection was not significantly associated with gender ($\chi2 = 0.16$, $p = 0.69$) or age category ($\chi2 = 0.01$, $p = 0.94$), indicating that the observed difference in infection frequency was more closely related to timing of shunt placement rather than demographic factors (Table 4).

Table:1 Demographic Characteristics of the Study Population (n = 154)

Variable	Group A (Simultaneous) n = 77	Group B (Delayed) n = 77	Total n = 154	Test value	p-value
Mean Age (months)	4.0 ± 1.8	4.2 ± 2.0	4.1 ± 1.9	t = 0.55	0.58
Age Group				$\chi2 = 0.74$	0.69
0 to 6 months	54 (70.1 %)	56 (72.7%)	110 (71.4 %)		
7 to 12 months	14 (18.2 %)	12 (15.6 %)	26 (16.9 %)		
Greater than 12 months	9 (11.7 %)	9 (11.7 %)	18 (11.7 %)		
Gender				$\chi2 = 0.13$	0.72
Male	47 (61.0%)	45 (58.4 %)	92 (59.7 %)		
Female	30 (39.0%)	32 (41.6 %)	62 (40.3 %)		

Table:2 Comparison of Post-operative Shunt Infection Between Groups

Outcome	Group A (Simultaneous) n = 77	Group B (Delayed) n = 77	Test value	p-value
Post-operative shunt infection	9 (11.7 %)	16 (20.8 %)	$\chi2 = 4.11$	0.04

Table:3 Comparison of Secondary Post-operative Outcomes Between Groups

Variable	Group A (Simultaneous) n = 77	Group B (Delayed) n = 77	Test value	p-value
VP shunt malfunction	7 (9.1 %)	10 (13.0 %)	$\chi2 = 0.61$	0.43
Wound CSF leak	5 (6.5 %)	9 (11.7 %)	$\chi2 = 1.27$	0.26
Post-operative hospital stay (days)	5.8 ± 2.1	7.4 ± 2.8	t = 3.41	0.001

Table:4 Stratification of Shunt Infection by Gender and Age (n = 154)

Variable	Infection Present n = 25	Infection Absent n = 129	Test value	p-value
Gender			$\chi2 = 0.16$	0.69
Male	14 (56.0 %)	78 (60.4 %)		
Female	11 (44.0%)	51 (39.6 %)		
Age Group			$\chi2 = 0.01$	0.94
0 to 6 months	18 (72.0 %)	92 (71.3 %)		
Greater than 6 months	7 (28.0 %)	37 (28.7 %)		

Discussion

The results of this study provide a significant contribution to the ongoing debate regarding the optimal timing for ventriculoperitoneal (VP) shunt insertion in the context of myelomeningocele (MMC) repair. Our findings indicated that postoperative VP shunt infection occurred in 25 out of 154 patients, with a notable incidence of 11.7% in the simultaneous shunting group compared to 20.8% in the delayed group (p = 0.04). This outcome aligns with the literature suggesting that early intervention may reduce the risk of infections that complicate shunt-related surgical procedures.

Demographic factors for our population showed a mean age of 4.1 ± 1.9 months and a gender composition of 59.7% male. These findings are comparable to those of White et al., who reported similar demographics in their group of 158 patients undergoing MMC closure, noting that age and gender did not play a significant role in infection rates after VP shunts were placed. (11) Moreover, we did not find any noteworthy age or gender variations in the groups of interventions, which is consistent with the outcomes reported by Mnguni et al., who identified that equal demographics are significant when examining the outcome of pediatric surgery. (12)

The rate of VP shunt infection in our cohort was similar to that reported in previous studies. The group with delayed shunts had higher infection rates than our simultaneous shunting group: 11.7% and 20.8, respectively (p = 0.04). This observation is consistent with the study by Elbaroody et al., who reported an increased incidence of infections associated with delayed shunt operations, and underscores the importance of the timing of the shunt intervention for positively influencing postoperative outcomes in pediatric neurosurgery. (13) It is also reinforced by findings of a study conducted by Asif et al., which showed that early VP shunt positioning correlates with lower infection rates in patients with hydrocephalus due to MMC. (14) Furthermore, a systematic review by Adebayo et al. helped to prove the assumption that infections become less common when shunting is conducted together with the main surgical procedure, which may provide some protective effect against the occurrence of further complications. (15)

Although the shunt malfunction rate was 9.1% in the simultaneous group and 13.0% in the delayed group (p = 0.43), the difference was not statistically significant. This is consistent with other reports by Valdivia et al., which found that although shunt complications, such as malfunction and obstruction, are frequent, their prevalence does not vary consistently over time. (16) Our observation on CSF leaks (6.5% in Group A and 11.7% in Group B) also showed no significant difference (p = 0.26), showing that though simultaneous shunting may be beneficial in infections, it does not significantly reduce other complications of shunting as has been established in other studies. (17,18)

Another significant finding was that the length of postoperative hospital stay was shorter for patients who underwent simultaneous shunting (5.8 ± 2.1 days) compared to those who had delayed shunting (7.4 ± 2.8 days). This result is consistent with previous research indicating that timely VP shunt placement may not only reduce infection risk but also lead to shorter hospitalizations and quicker recovery times, as suggested by a meta-analysis by Chiu et al. (19). Our results support optimizing surgical practices to enhance patient outcomes.

In our stratified analysis, we found that the rate of infection by the shunt was not significantly related to demographic variables, including age or gender. This is consistent with other literature, and previous research by Zakaria et al. observed that demographic characteristics might not be directly related to the increased risk of postoperative infection among pediatric patients. (20) Timing is obviously connected with the results of the infection as opposed to demographic features, which highlights the importance of the need to concentrate on the model of surgery as opposed to a patient's history on its own

Our findings have important implications for Pakistan, where access to timely surgical interventions and limited resources for medical care might be relevant. Since MMC and the frequent complications are more common in pediatric populations, finding the best time to place a VP shunt may reduce the number of hospitalization burdens and postoperative complications, which is in line with the results of the local studies where Ahmed et al. stated that there are high cases of shunt infections and recommended the adoption of the best surgical practice. (21)

This study was conducted at a single center, which may limit the generalizability of the findings. The three-month follow-up period may not capture late shunt infections or long-term complications. Non-probability sampling may introduce selection bias, and subtle differences in surgical or postoperative care could have influenced outcomes.

Conclusion

Simultaneous placement of a ventriculoperitoneal shunt during myelomeningocele repair reduces postoperative infections and the length of hospital stay, compared to delayed shunt placement. Other complications, such as shunt malfunction and cerebrospinal fluid leakage, did not differ between the groups, which suggests that simultaneous shunting is a better and safer method. These results reinforce the idea that simultaneous shunt placement should be used as the method of choice in children with myelomeningocele and hydrocephalus, especially in environments where the decreasing risk of infections and the minimization of the burden on the hospital are needed.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-BVH-32e-25)

Consent for publication

Approved

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Conflict of interest

The authors declared no conflict of interest.

Author Contribution

SSK (PGR)
Manuscript drafting, Study Design,
SS (Professor & HOD)
Review of Literature, Data entry, Data analysis, and drafting articles.
WR (FCPS)
Conception of Study, Development of Research Methodology Design

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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