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Dural Reconstruction Strategies in Postnatal Myelomeningocele Repair and Their Clinical Outcomes: Experience from a Tertiary Care Centre

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ABSTRACT

Objective: The use of adjunct materials to facilitate dural closure has become an important aspect of spina bifida surgery. This study evaluated different dural reconstruction techniques used during myelomeningocele (MMC) repair and compared their clinical outcomes in a tertiary care centre.
Materials and Methods: A retrospective observational study was conducted on 46 patients who underwent surgical correction forMMC. Patient demographics, preoperative imaging, surgical details, and postoperative complications were documented. The choice of dural repair technique was based on intraoperative defect size, native dural availability, tissue tension, and surgeon preference. All patients were followed for six months post-repair.
Results: The mean age was 12 months; 56.52% were female. The lumbosacral region was affected in 86.95% of cases. Primary dural repair was performed in 20 patients (43%), autologous grafts were used in 11 (24%), and synthetic grafts were used in 15 (33%). Compared with primary closure, graft-based reconstruction was associated with significantly higher odds of wound necrosis (OR 5.46, 95% CI 1.39–21.46, p=0.016), wound dehiscence (OR 7.74, 95% CI 1.81–33.12, p=0.006), CSF leakage (OR 5.67, 95% CI 1.58–20.28, p=0.009), and secondary surgery (OR 12.27, 95% CI 2.33–64.56, p=0.002). No statistically significant differences were identified between autologous and synthetic graft groups.
Conclusion: Primary dural closure, when anatomically feasible, was associated with lower postoperative wound complications, CSF leakage, and reoperation rates than graft-based reconstruction. Autologous and synthetic grafts remain useful alternatives when primary closure is not feasible.

Keywords: *myelomeningocele, meningomyelocele, dural closure, duraplasty, spina bifida, cerebrospinal fluid leak.*

INTRODUCTION

Myelomeningocele (MMC) remains one of the most severe forms of open neural tube defects, associated with significant neurological morbidity[1]. Advances in prenatal diagnosis and the advent of fetal surgical repair have altered the management paradigm in selected cases [2].Despite advances in prenatal repair, postnatal surgical closure remains the standard treatment in many low- and middle-income countries, particularly in patients who are unsuitable for fetal intervention or in regions where access to specialized fetal surgery programs is limited.

Postnatal repair of MMC includes repair of the neural placode with the help of autologous dura [3]. Grafts are used as an adjunct in the repair in cases where the defect size is large and primary repair of the dura mater is not possible [4].While the idea of using a patch for duraplasty as a dural substitute dates back to the 1970s,yet to this day, there is still not a “perfect” patch that has been developed for MMC repair.[5]. Recent studies suggest that the choice of dural repair technique may influence thepost-operative complications encountered. However, comparative evidence regarding outcomes of different dural closure methods during postnatal MMC repair remains limited, particularly in real-world tertiary care settings [6].

Given this gap, the present study aims to evaluate the clinical outcomes associated with different dural reconstruction techniques during MMC repair at a tertiary care neurosurgical centre, with a focus on postoperative complications and the need for secondary surgical interventions. By correlating outcomes with repair type, this study provides evidence to guide surgical decision-making and optimize patient care.

MATERIALS AND METHODS

Study Design

A retrospective observational study was performed involving patients who underwent surgical repair forMMC between January 2020 and June 2025. Preoperative evaluation in all cases consisted of detailed imaging of both the brain and spinal cord. Patients diagnosed with associated hydrocephalus underwent ventriculoperitoneal shunt placement prior to definitive MMC repair.

Data regarding patient demographics, neurological status at presentation, anatomical level of the defectand the technique used for dural closure were collected from medical records. Postoperative complications were documented, and clinical follow-up was carried out for a period of up to six months following surgery.

Study Population

Patients aged 0–11 years who underwent surgical repair for MMC were included in the study. Patients with an infected wound, those who were immunocompromised, and patients who were lost to follow-up before completion of six months were excluded from the study.(Figure 1)

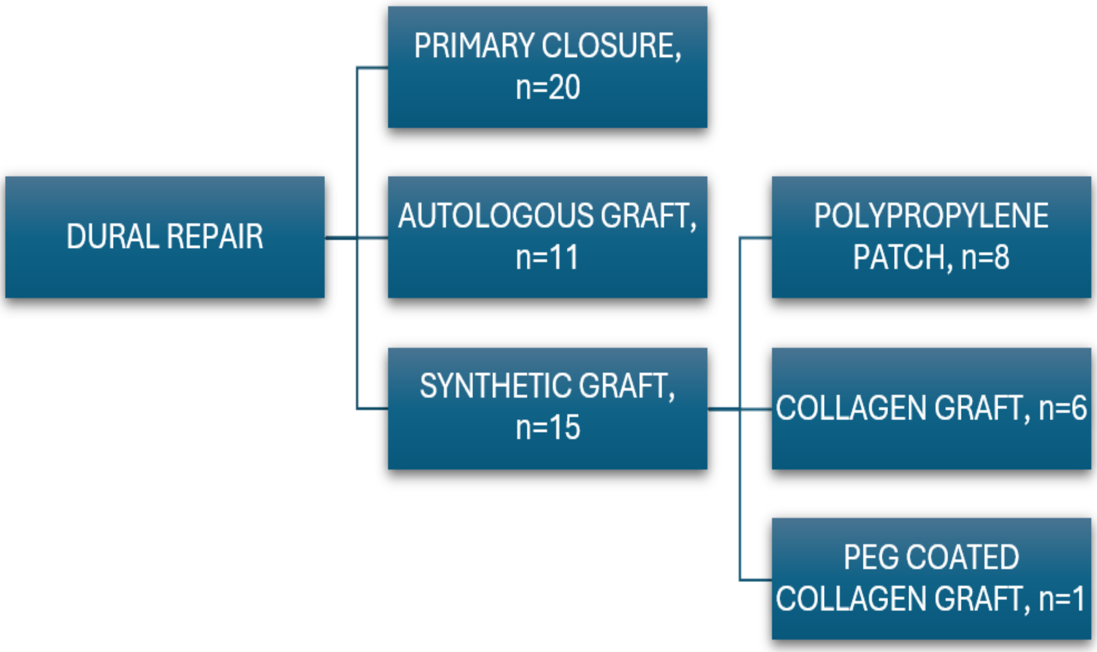

Figure 1: Dural Repair Strategies and Graft Categorization

Surgical Procedure

Under general anaesthesia, patients were positioned prone with adequate padding to allow the chest and abdomen to remain free. Local infiltration with lignocaine containing 0.25% adrenaline was administered subcutaneously along the planned incision line. A transverse incision was made over the dome of the swelling and deepened through the subcutaneous tissue. The neural placode was then identified and carefully dissected away from the surrounding abnormal skin and dysplastic meningeal tissue. Following adequate mobilisation, the dysplastic tissue was excised and the neural tube was reconstructed.Once neural tube closure was achieved, the dural plane was identified and dural repair was performed (Figure 2). The choice of dural reconstruction method was determined intraoperatively according to defect size, adequacy of native dura for tension-free closure, surrounding soft tissue quality, and surgeon judgment.After completion of dural reconstruction, the surrounding skin wasmobilised, and the wound was closed primarily over a drain.

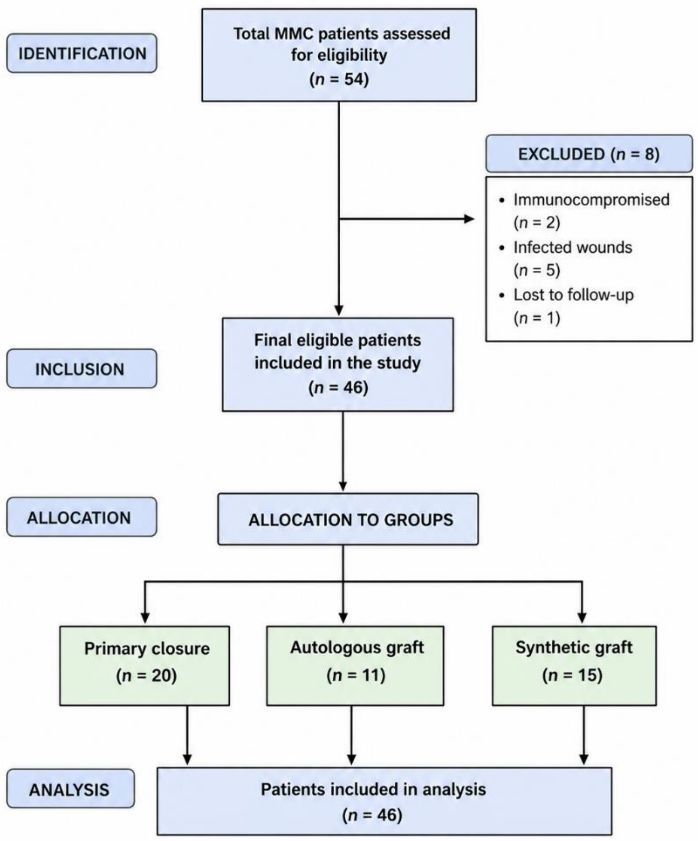

Figure 2: **Flow diagram of patient selection and allocation.**

CONSORT-style flowchart depicting the study cohort of 54 patients with myelomeningocele (MMC) assessed for eligibility. After exclusion of 8 patients (2 immunocompromised, 5 with infected wounds, and 1 lost to follow-up), a total of 46 patients were included in the final analysis. The included patients were allocated into three groups based on the dural reconstruction technique: primary closure (n = 20), autologous graft (n = 11), and synthetic graft (n = 15).

Statistical analysis

Data analysis was performed using IBM SPSS Statistics (version 20.0; IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages.

Comparisons between categorical variables were performed using the Chi-square test or Fisher's exact test, as appropriate. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to assess the association between dural reconstruction techniques and postoperative outcomes.

To further evaluate the independent effect of dural repair technique on postoperative complications, univariate logistic regression analysis was performed. Given the retrospective design and limited sample size, multivariate adjustment was not performed; however, clinically relevant variables such as age, lesion level, and preoperative neurological status were assessed descriptively for potential confounding.

All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

Ethics Statement

This study was conducted after institutional approval in accordance with hospital policy for retrospective record-based studies. Formal IEC approval was not required for anonymized data review.Patient confidentiality was strictly maintained, and all data were de-identified prior to analysis. The study was conducted in accordance with the Declaration of Helsinki.

RESULTS

During the study period, 54 patients were admitted with a diagnosis of myelomeningocele. Of these, 2 patients were immunocompromised, 5 had preoperative wound infections, and 1 patient was lost to follow-up. After excluding these patients, 46 patients were eligible for analysis.

The mean age of the cohort was 12 months, with 26 females and 20 males. Preoperatively, 10 patients presented with paraparesis, 5 with bowel and bladder incontinence, and 2 with complete paraplegia. The majority of lesions were located in the lumbosacral region (86.95%), while 5 patients (10.86%) had dorsal lesions and 1 patient (2.17%) had a cervical lesion.

Primary dural closure was performed in 20 patients, autologous grafts were used in 11 patients, and synthetic grafts in 15 patients. Demographic and clinical characteristics according to the type of dural repair are summarized in Table 1. Secondary surgical needs and complication rates according to dural repair type are shown in Table 2. The synthetic graft group has been further divided based on the type of synthetic graft used (Table 3).

TABLE 1: Comparison of the demographic and clinical characteristics of the patients according to type of dural repair

Feature	Primary Closure (n=20)	Autologous Graft (n=11)	Synthetic Graft (n=15)
Gender, n(%)			
- Male	8 (40)	5(45.45)	7(46.67)
- Female	12(60)	6(54.54)	8(53.33)
Preoperative neurological status, n(%)			
- Paraparesis	6(30)	3(27.27)	1(6.67)
- Paraplegia	1(5)	-	1(6.67)
- Urinary incontinence	2(10)	2(18.18)	2(13.33)
Anatomical Location, n(%)			
- Lumbosacral	19(95)	8(72.72)	13(86.67)
- Dorsal	1(5)	3(27.27)	1(6.67)
- Cervical	-	-	1(6.67)

TABLE 2: Postoperative complications and secondary surgical interventions according to type of dural repair

Complication / Outcome	Primary Closure (n=20)	Autologous Graft (n=11)	Synthetic Graft (n=15)	OR (95% CI) (Primary vs Any Graft)	p-value (Primary vs Any Graft)	OR (95% CI) (Autologous vs Synthetic)	p-value (Autologous vs Synthetic)
Wound necrosis, n (%)	4 (20.0%)	7 (63.6%)	8 (53.3%)	5.46 (1.39-21.46)	0.016	0.65 (0.14-3.10)	0.701
Wound dehiscence, n (%)	3 (15.0%)	6 (54.5%)	9 (60.0%)	7.74 (1.81-33.12)	0.006	1.25 (0.28-5.59)	1.000
CSF leak, n (%)	5 (25.0%)	8 (72.7%)	9 (60.0%)	5.67 (1.58-20.28)	0.009	0.56 (0.10-3.09)	0.680
Secondary surgery, n (%)	2 (10.0%)	7 (63.6%)	8 (53.3%)	12.27 (2.33-64.56)	0.002	0.65 (0.14-3.10)	0.701

TABLE 3: Postoperative Complications in Synthetic Graft Subtypes

Synthetic Graft Subtype	n	Wound Necrosis, n (%)	Wound Dehiscence, n (%)	CSF Leak, n (%)	Secondary Surgery, n (%)
Polypropylene patch	8	5(62.5%)	5(62.5%)	5(62.5%)	4(50.0%)
Collagen graft	6	3(50.0%)	4(66.7%)	4(66.7%)	4(66.7%)
PEG-coated collagen patch	1	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Wound complications: Wound necrosis occurred in 4 patients (20%) in the primary closure group, compared with 7 patients (63.6%) in the autologous graft group and 8 patients (53.3%) in the synthetic graft group. Primary closure was associated with a lower rate of wound necrosis compared with graft-based repair (p=0.016).No statistically significant difference was observed between autologous and synthetic grafts (p = 0.701).

Wound dehiscence was observed in 3 patients (15%) following primary closure, 6 patients (54.5%) in the autologous graft group, and 9 patients (60%) in the synthetic graft group. Primary dural repair demonstrated a lower rate of wound dehiscence compared to grafted repairs (p = 0.006). The difference between autologous and synthetic grafts was not statistically significant (p = 1.0).

CSF leaks: Cerebrospinal fluid leak occurred in 5 patients (25%) undergoing primary dural closure, compared with 8 patients (72.7%) in the autologous graft group and 9 patients (60%) in the synthetic graft group. Primary closure was associated with a reduced incidence of CSF leak when compared to graft-based dural reconstruction (p = 0.009). No significant difference was observed between autologous and synthetic grafts (p = 0.68).

Secondary surgery: Secondary surgical intervention was required in 2 patients (10%) following primary closure, compared to 7 patients (63.6%) in the autologous graft group and 8 patients (53.3%) in the synthetic graft group. The requirement for secondary surgery was lower in patients undergoing primary dural repair compared with those receiving grafts (p = 0.002). No statistically significant difference was observed between autologous and synthetic grafts (p = 0.701)..

DISCUSSION

Myelomeningocele (MMC) remains a complex congenital anomaly with significant neurological morbidity [1]. While prenatal diagnosis and fetal repair have transformed management in selected cases, postnatal repair continues to be the standard in most regions, particularly in resource-limited settings [2].Surgical repair aims not only to protect neural elements but also to achieve a durable, watertight closure that minimizes cerebrospinal fluid (CSF) leakage, wound complications, and the need for reoperation. In this context, the choice of dural reconstruction technique remains a critical determinant of postoperative outcomes.

In the present study, primary dural closure demonstrated significantly lower rates of wound necrosis, wound dehiscence, CSF leakage, and secondary surgical intervention compared with graft-based reconstruction.These findings suggest that tension-free primary repair using native tissue may offer better tissue compatibility and improved wound healing [7,8].

Wound-related complications remain among the most common challenges following MMC repair. In our cohort, patients undergoing primary closure had markedly fewer wound complications than those receiving autologous or synthetic grafts. This aligns with prior reports highlighting that devascularized autologous tissue and synthetic materials may impair healing, particularly in neonates and infants with fragile soft tissue [9,10]. Preservation of native dura may reduce tissue handling and foreign-body response, thereby supporting wound healing.

CSF leakage is another critical concern, as it predisposes patients to meningitis, wound breakdown, and reoperation. Our results indicate that primary dural repair was associated with fewer CSF leaks in this cohort, compared to patch duraplasty. This is consistent with prior reports demonstrating that native dura provides a more watertight barrier and reduces the risk of postoperative CSF egress, particularly at graft-host interfaces [10,11]. These findings underscore the importance of meticulous closure techniques and careful intraoperative handling of native dural tissue.

Secondary surgical interventionwas significantly reduced in the primary closure group. Reoperations after MMC repair often result from wound complications or persistent CSF leakage, contributing to longer hospital stays, increased healthcare costs, and higher caregiver burden [11,12]. Minimizing the need for secondary procedures through primary dural repair may provide both clinical and socioeconomic benefits, especially in high-volume tertiary centers.

Within graft-based repairs, variability was observed among materials. Conventional synthetic and collagen-based grafts demonstrated higher complication rates. Although the PEG-coated collagen patch subgroup showed no complications, this finding is based on a single case and should be interpreted cautiously. Existing literature on dural substitutes suggests improved handling characteristics and acceptable safety profiles, but no clear superiority of newer bioactive or coated materials has been established [13,14].Prospective studies with larger cohorts are needed to validate these observations and to determine the optimal synthetic or autologous dural substitute in cases where primary closure is not feasible.

Finally, this study highlights the continued importance of surgical expertise and individualized decision-making. Anatomical factors such as defect size, surrounding soft tissue quality, and the extent of neural placode involvement influence the feasibility of primary closure. Surgeons must balance the risks of tension at the repair site against the benefits of using native dura to minimize postoperative morbidity [15].

Limitations

This study is limited by its retrospective single-centre design, relatively small sample size, and non-randomized treatment allocation. Selection bias and confounding by defect size or lesion severity cannot be excluded. The six-month follow-up period may not capture late complications such as tethered cord syndrome or delayed CSF-related issues. Prospective, multicentre studies with longer follow-up are required to validate these findings and establish standardized guidelines.

CONCLUSION

Primary dural closure in myelomeningocele repair, when anatomically feasible, was associated with lower rates of wound complications, CSF leakage, and secondary surgical intervention compared with graft-based reconstruction. Preservation of native dural tissue may provide improved tissue compatibility and a more watertight closure, highlighting its role as the preferred technique whenever anatomically feasible. Synthetic or autologous grafts remain valuable alternatives in cases where primary closure is not possible, with emerging bioactive and sealant-coated materials showing promise in reducing postoperative complications. These findings support a tailored surgical approach, emphasizing meticulous technique and evidence-based selection of closure materials to optimize patient outcomes.

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