

Research Article

Impact of Defect Closure Technique on Postoperative Outcomes Following Myelomeningocele Repair: A Prospective Clinical Study

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Abstract: Background: Myelomeningocele is one of the most severe forms of spinal neural tube defect and requires surgical repair to achieve adequate coverage of the exposed neural structures. The method of defect closure may influence postoperative wound healing and complications. The present study was undertaken to assess the impact of defect closure technique on postoperative outcomes following myelomeningocele repair. **Aim:** To evaluate the impact of different defect closure techniques, particularly rotation flap closure, on postoperative outcomes following myelomeningocele repair. **Methods:** A prospective clinical study was conducted in patients undergoing surgical repair of spinal neural tube defects. A total of 30 patients were included. Clinical, operative and postoperative parameters were recorded. The defect closure technique, including use of rotation flap, was assessed in relation to postoperative complications, particularly cerebrospinal fluid (CSF) leakage and wound-related complications. **Results:** Rotation flap closure was performed in 7 (23.33%) patients, while 23 (76.67%) patients underwent closure without rotation flap. Postoperative CSF leakage occurred in 6 (20%) patients, whereas 24 (80%) patients had no CSF leakage. None of the patients who underwent rotation flap closure developed postoperative CSF leakage. In comparison, all 6 cases of CSF leakage occurred in the non-rotation-flap group. However, the association between rotation flap closure and CSF leakage was not statistically significant ($p = 0.29$). The study also demonstrated favorable wound outcomes in patients undergoing rotation flap closure, with no wound dehiscence reported in this group. **Conclusion:** The findings suggest that appropriate selection of defect closure technique is an important component of myelomeningocele repair. Rotation flap closure showed favorable postoperative outcomes, particularly with respect to CSF leakage and wound dehiscence, and may be useful in selected defects where primary closure is difficult. However, the small sample size and lack of statistical significance limit definitive conclusions regarding its superiority. Larger prospective studies with longer follow-up are required to further establish the impact of closure technique on postoperative outcomes.

Keywords: Myelomeningocele, Neural tube defect, Defect closure, Rotation flap, Primary closure, Cerebrospinal fluid leak, Wound dehiscence, Postoperative outcome, Surgical repair, Spina Bifida

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INTRODUCTION

Myelomeningocele (MMC) is a severe form of spinal neural tube defect associated with significant neurological and functional morbidity. Children who survive with myelomeningocele may develop lifelong disabilities, and functional problems may arise either from the primary neurological defect or from the surgical repair itself [1]. Therefore, achieving safe and effective surgical closure of the defect is an important component of the management of these patients. Spina bifida is an important congenital defect of the central nervous system compatible with survival. Myelomeningocele can affect multiple aspects of a child's health and functioning, including mobility, activities of daily living, continence, learning and social interaction [2]. The extent of these problems varies according to the neurological involvement and level of the lesion.

The incidence of neural tube defects varies considerably among different populations, with reported worldwide rates ranging from 0.17 to 6.39 per 1000 live births. Changes in the incidence of myelomeningocele have also had an important impact on pediatric neurosurgical practice and management [3]. Despite advances in medical and surgical care, affected children may continue to experience significant long-term complications, including hydrocephalus, cognitive dysfunction, urinary and fecal incontinence, reduced mobility, renal dysfunction, pressure sores and orthopedic problems such as scoliosis, fractures and contractures [3]. The consequences of myelomeningocele may extend beyond the neonatal and childhood periods. Adults with myelomeningocele may continue to experience functional limitations that can influence independence and overall life satisfaction [4]. Similarly, cognitive difficulties have been reported among young adults with spina bifida, further demonstrating the long-term impact of the condition [5].

Surgical repair of myelomeningocele is performed to close the spinal defect and provide adequate protection of the exposed neural structures. However, the outcome following repair may be influenced by several clinical and surgical factors [1]. Among these, the technique used to achieve closure of the defect is particularly important, especially in patients with larger defects where direct skin closure may not provide adequate coverage.

The size of the defect can influence the selection of the surgical closure technique. In the study described in the thesis, defects smaller than 8% of the thoracolumbar region were primarily sutured, whereas defects occupying more than 8% were managed with muscle-skin flaps [6]. Muscle-skin flap techniques have been described as an alternative for broad-based meningomyelocele defects because they can provide wider coverage and additional protection to the repaired defect [6].

Postoperative complications are an important determinant of the success of myelomeningocele repair. Inadequate or difficult closure may contribute to problems such as cerebrospinal fluid leakage, wound infection and wound dehiscence. Although several surgical factors have been discussed in the literature, the method of defect repair, particularly the role of flap rotation, has not been adequately studied in combination with other factors affecting surgical outcome. The choice between primary/direct closure and flap-based closure is therefore clinically relevant in patients undergoing myelomeningocele repair. A closure technique that provides adequate tissue coverage may help achieve better wound healing and reduce postoperative complications. Evaluation of postoperative outcomes according to the technique used for defect closure can consequently provide useful information for surgical decision-making.

In addition to surgical factors, neural tube defects are influenced by several maternal and environmental factors. Maternal hyperthermia during early pregnancy has been associated with an increased risk of neural tube defects, as demonstrated in a systematic review and meta-analysis [6].

Considering the significant morbidity associated with myelomeningocele and the importance of achieving secure closure of the spinal defect, the present study was undertaken to evaluate the impact of defect closure technique on postoperative outcomes following myelomeningocele repair, with particular emphasis on postoperative wound complications and surgical recovery. The study aims to compare outcomes associated with different methods of defect closure and to determine whether the technique of closure is associated with improved postoperative results.

MATERIALS AND METHODS

A prospective analytical clinical study was conducted at G.B. Pant Institute of Post Graduate Medical Education and Research, New Delhi, during the period 2020–2021. The study included patients with spinal neural tube defects who fulfilled the predefined inclusion criteria. Patients who had undergone previous surgery for neural tube defects were excluded from the study. The study was designed to assess clinical, radiological and surgical factors associated with surgical outcome following repair.

For the present study, particular emphasis was placed on the technique used for closure of the myelomeningocele defect and its relationship with postoperative outcome. The size of the defect was considered while selecting the method of closure. Defects measuring less than 8% of the thoracolumbar region were closed primarily by direct suturing and classified as Grade 1, whereas defects occupying more than 8% of the thoracolumbar region were closed using muscle-skin flaps and classified as Grade 2. All eligible patients underwent preoperative clinical and radiological assessment. Relevant clinical, radiological and surgical parameters were recorded. The surgical procedure included repair and closure of the myelomeningocele defect according to the characteristics and size of the defect. Where adequate primary closure was not possible, flap-based closure was utilized to achieve appropriate coverage of the defect. Postoperatively, patients were followed for assessment of surgical outcomes and complications related to the method of defect closure. Particular attention was given to cerebrospinal fluid leakage, wound infection and wound dehiscence, as these represent important postoperative outcomes following myelomeningocele repair. The association between the closure technique and postoperative complications was assessed.

Neurological status was assessed in the preoperative and postoperative periods using the Spina Bifida Neurological Scale (SBNS). The SBNS evaluates motor function, reflexes, and bladder and bowel function and provides a standardized method for assessing neurological status and its changes following treatment. The sample size calculation in the source thesis was based on an expected postoperative wound infection rate of 8%, a 95% confidence level and an absolute error of 5%. Using the formula $n = Z\alpha^2 pq/d^2$, the calculated sample size was 113, however, a convenient sample size of 30 patients was included in the study. The collected data were analyzed to determine the relationship between the defect closure technique and postoperative outcomes following myelomeningocele repair. The primary focus was to assess whether the method of closure was associated with differences in postoperative wound complications and overall surgical outcome.

RESULTS

A total of 30 patients who underwent surgical repair for spinal neural tube defects were included in the study. The analysis was focused on the relationship between the defect closure technique, particularly rotation flap closure, and

Table 1: Distribution According to Defect Closure Technique

Defect closure technique	Number of patients	Percentage
No rotation flap	23	76.67
Rotation flap	7	23.33
Total	30	100

Table 2: Overall Postoperative CSF Leak

Postoperative CSF leak	Number of patients	Percentage
No leak	24	80.00
Leak	6	20.00
Total	30	100

Table 3: Association Between Rotation Flap Closure and Postoperative CSF Leak

Rotation flap	No leak n (%)	Leak n (%)	Total n (%)
No	17 (70.83%)	6 (100.00%)	23 (76.67%)
Yes	7 (29.17%)	0 (0.00%)	7 (23.33%)
Total	24 (100%)	6 (100%)	30 (100%)

P = 0.29, Fisher's exact test

Table 4: Postoperative Outcome According to Rotation Flap Closure

Outcome	Rotation flap (n = 7)	No rotation flap (n = 23)
CSF leak	0	6
No CSF leak	7	17

Table 5: Overall Postoperative Wound Complications

Postoperative wound outcome	Number	Percentage
Wound complication present	6	20
No wound complication	24	80
Total	30	100

Table 6: Muscle Flap Strengthening and Postoperative Complication

Muscle flap strengthening	Number	Postoperative complication
Yes	7 (23.33%)	0 cases
No	23 (76.67%)	Not separately quantified in the cited result

postoperative outcomes. The available operative records showed that rotation flap closure was performed in 7 (23.33%) patients, whereas 23 (76.67%) patients underwent closure without a rotation flap. The rotation flap was used in 7 of the 30 patients (23.33%) Table 1-2. Postoperative CSF leakage was observed in 6 (20.00%) patients, while 24 (80.00%) patients did not develop a postoperative CSF leak.

Thus, postoperative CSF leakage occurred in 20% of the study population. The relationship between rotation flap closure and postoperative CSF leakage was subsequently analyzed. Of the 24 patients who did not develop CSF leakage, 7 (29.17%) had undergone rotation flap closure and 17 (70.83%) had not. Among the 6 patients who developed CSF leakage, none had undergone rotation flap closure, whereas all 6 (100%) belonged to the non-rotation-flap group. The association between rotation flap closure and CSF leakage was not statistically significant ($p = 0.29$, Fisher's exact test) Table 3.

The data therefore showed that none of the patients who underwent rotation flap closure developed postoperative CSF leakage, whereas CSF leakage was observed in 6 patients in the non-rotation-flap group. However, because of the small number of patients undergoing rotation flap closure, the difference did not reach statistical significance Table 4.

The individual patient records further demonstrated that the patients who underwent rotation flap closure had no postoperative CSF leak. Rotation flap closure was documented in the relevant cases and was accompanied by satisfactory postoperative wound status.

The thesis specifically reports that patients who underwent rotational flap closure performed better postoperatively, with no CSF leak or wound dehiscence observed in patients who underwent rotation flap closure.

Overall, wound complications were reported in 20% of cases. The thesis notes that wound dehiscence followed by wound infection were the most frequent postoperative complications. It also reports that appropriate skin flap techniques may help decrease wound-related complications Table 5.

The study further documented that muscle flap strengthening was performed in 7 (23.33%) cases, and none of these patients developed a postoperative complication. Musculocutaneous flaps were considered a safe alternative providing good neural coverage and good postoperative outcome Table 6.

The findings of the study suggest a favorable postoperative outcome among patients managed with flap-based closure. In particular, rotation flap closure was associated with absence of postoperative CSF leakage and wound dehiscence in this study. However, the statistical association between rotation flap and CSF leak was not significant ($p = 0.29$).

DISCUSSION

The present prospective clinical study evaluated the impact of defect closure technique on postoperative outcomes following myelomeningocele repair. The main focus was the relationship between the method of defect closure and postoperative complications, particularly CSF leakage and wound-related complications. Myelomeningocele is associated with significant neurological and functional morbidity, making appropriate surgical management important for achieving better long-term outcomes [7]. The choice of closure technique becomes particularly important in larger defects where primary closure may be difficult or may produce excessive wound tension. In the present study, rotation flap closure was performed in 7 of 30 patients (23.33%), while 23 patients underwent closure without rotation flap. Defect size is an important factor in selecting the appropriate closure technique. Ozveren *et al.* emphasized the importance of defect size in determining the surgical technique and described muscle-skin flaps as a useful option for broad-based defects [8]. Neurological assessment is also an important component of postoperative evaluation. Oi and Matsumoto proposed the Spina Bifida Neurological Scale (SBNS) for standardized assessment of motor, reflex and bladder/bowel functions in patients with spina bifida [9]. Idris also reported that postoperative outcomes following myelomeningocele repair are influenced by multiple clinical and neurological factors [10]. In the present study, postoperative CSF leakage occurred in 6 patients (20%). Importantly, none of the 7 patients who underwent rotation flap closure developed CSF leakage, whereas all 6 patients with CSF leakage belonged to the non-rotation-flap group. However, the difference was not statistically significant ($p = 0.29$). This finding suggests a favorable clinical trend with rotation flap closure, although a larger sample would be required to establish statistical significance.

Reynolds *et al.* also highlighted the importance of postoperative complications such as CSF leakage and infection following myelomeningocele repair [11]. Similarly, Shim *et al.* reported the use of direct repair and local flap techniques for myelomeningocele closure and demonstrated that flap procedures can be useful in selected defects [12].

Overall, the present study suggests that appropriate selection of defect closure technique may contribute to favorable postoperative outcomes. Rotation flap closure showed encouraging results, particularly with respect to CSF leakage and wound dehiscence. However, because of the small sample size and lack of statistical significance, larger prospective studies are needed to confirm these findings.

CONCLUSION

The present prospective clinical study evaluated the effect of defect closure technique on postoperative outcomes following myelomeningocele repair. In this study, rotation flap closure was performed in 7 (23.33%) patients. Patients who underwent rotation flap closure showed favorable postoperative outcomes, with no CSF leakage or wound dehiscence observed in this group. Postoperative CSF leakage was observed in 6 (20%) patients overall. Although no CSF leakage was observed among patients who underwent rotation flap closure, the association between rotation flap and CSF leakage was not statistically significant ($p = 0.29$). The findings of the study suggest that flap-based closure, particularly rotation flap closure, can be a useful surgical option for selected myelomeningocele defects, especially when adequate primary closure is difficult. Muscle-skin flap closure provides additional tissue coverage and may contribute to satisfactory postoperative wound healing. However, the present study was limited by its small sample size, single-centre design and relatively short follow-up period. Therefore, larger prospective studies with longer follow-up are required to further evaluate the role of different defect closure techniques and to determine their effect on postoperative complications following myelomeningocele repair.

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