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Research Article

Predictors of Neurological Outcome After Myelomeningocele Repair: The Role of Clinical, Surgical and Blood Group Factors Assessed Using the Spina Bifida Neurological Score

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Abstract: Background: Myelomeningocele is a major neural tube defect associated with varying degrees of neurological dysfunction and postoperative complications. Neurological outcome following surgical repair may be influenced by several clinical, anatomical and surgical factors. The Spina Bifida Neurological Score (SBNS) provides an objective method for assessing neurological function. Blood-group characteristics have also been explored in relation to neural tube defects, but their relationship with postoperative outcomes remains inadequately studied. **Objective:** To assess the clinical and surgical factors associated with neurological outcome after myelomeningocele repair using the Spina Bifida Neurological Score and to evaluate the association of ABO and Rh blood groups with postoperative outcomes. **Methods:** A prospective observational study was conducted among 30 patients with myelomeningocele undergoing surgical repair. Demographic, clinical, radiological and intraoperative variables were recorded. ABO and Rh blood groups were documented. Neurological status was assessed using the SBNS before and after surgery. Postoperative complications, particularly cerebrospinal fluid (CSF) leak, were recorded. Appropriate statistical tests were applied, with $p<0.05$ considered statistically significant. **Results:** Among the 30 patients, 60% were males and 40% were females. The mean age was 13.72±17.41 months. A-positive was the most common blood group (40%), followed by O-positive (23.33%) and B-positive (20%). The mean preoperative and postoperative SBNS were 9.93±3.39 and 9.87±3.32, respectively, with no statistically significant difference ($p = 0.326$). Neurological status remained unchanged in 86.67% of patients, deteriorated in 10% and improved in 3.33%. Postoperative CSF leak occurred in 20% of patients. No statistically significant association was observed between blood group and CSF leak ($p = 0.384$). Similarly, the association between change in SBNS and CSF leak was not statistically significant ($p = 0.28$). **Conclusion:** Most patients demonstrated stable neurological status following myelomeningocele repair. Although A-positive was the most frequent blood group (40%), no significant association was found between ABO/Rh blood-group status and postoperative CSF leak ($p = 0.384$). Larger studies are required to further evaluate the role of blood-group characteristics in postoperative outcomes.

Keywords: Myelomeningocele, Spina Bifida, Spina Bifida Neurological Score, SBNS, Neurological Outcome, Surgical Repair, Clinical Predictors, Surgical Predictors, CSF Leak, Hydrocephalus

INTRODUCTION

Myelomeningocele (MMC) is the most severe form of spina bifida and is associated with variable degrees of neurological impairment involving motor function, reflexes and bladder and bowel function. The neurological status of patients with myelomeningocele may change with growth and development, making objective and reproducible assessment of neurological function important during follow-up. To facilitate standardized assessment, Oi and Matsumoto proposed the Spina Bifida Neurological Scale (SBNS) in 1992. The SBNS provides a quantitative method for assessing neurological function in patients with spina bifida by incorporating important clinical domains including motor function, reflexes and bladder and bowel function. Thus, the SBNS can be used to document neurological status and evaluate changes over time [1].

The clinical usefulness of the SBNS has been demonstrated in children following myelomeningocele repair. Idris evaluated factors affecting outcomes in children after myelomeningocele repair and assessed both ambulatory and sphincter functions. The study demonstrated that multiple factors contribute to functional outcomes following repair and emphasized the usefulness of the SBNS in the management of these children, particularly for identifying neurological deterioration during follow-up. This highlights the importance of combining clinical assessment with a standardized neurological scoring system when evaluating postoperative outcomes [2].

Although surgical repair is essential for protecting exposed neural tissue and achieving closure of the defect, postoperative neurological outcome may vary considerably between patients. Recent evidence has investigated the relationship between preoperative and intraoperative factors and postoperative neurological outcomes. Acosta-Medina *et al*. specifically evaluated preoperative and intraoperative risk factors associated with postoperative neurological

outcomes following postnatal surgical correction of myelomeningocele. Their findings support the importance of identifying clinical and surgical characteristics that may influence neurological outcome after repair [3].

The assessment of neurological and functional outcomes has also been emphasized in the Management of Myelomeningocele Study (MOMS). In this study, children with myelomeningocele were evaluated for neurological and functional outcomes following different approaches to management. Functional assessment included evaluation of motor development and independent ambulation, demonstrating the importance of standardized outcome assessment when determining the neurological and functional consequences of myelomeningocele and its treatment [4].

Ambulation is an important functional manifestation of neurological status in children with myelomeningocele. Davis *et al*., using data from the National Spina Bifida Patient Registry, evaluated factors associated with ambulation in individuals with myelomeningocele. Their longitudinal analysis demonstrated that mobility outcomes are influenced by multiple clinical factors. These findings emphasize that postoperative functional outcome is multifactorial and that assessment of neurological status should take into account relevant clinical characteristics rather than relying solely on the presence or anatomical location of the spinal defect [5].

The neurological level of the spinal lesion is another important determinant of functional outcome. In a study of 1500 patients with myelomeningocele, Díaz Llopis *et al*. evaluated factors related to ambulation and demonstrated the importance of neurological level in determining walking ability. Their findings support the concept that the level and severity of neurological involvement are closely related to subsequent functional outcome in patients with myelomeningocele [6].

Similarly, Cochrane *et al*. demonstrated the importance of spinal lesion characteristics in predicting neurological and functional outcomes in patients born with myelomeningocele. Their study showed that prenatal spinal evaluation could provide useful information regarding expected neurological function and functional prognosis. These findings further support the importance of anatomical and neurological characteristics when evaluating outcome after myelomeningocele repair [7].

Despite advances in the surgical management of myelomeningocele, postoperative neurological outcome remains variable. Clinical factors such as neurological level and preoperative neurological status, together with surgical and intraoperative factors, may influence the final outcome. Therefore, objective assessment of neurological function before and after repair is important for identifying changes in neurological status and determining factors associated with postoperative outcome. The Spina Bifida Neurological Score, by providing a standardized assessment of motor, reflex and bladder/bowel function, may be particularly useful for this purpose [1,2].

Hence, the present study is designed to evaluate clinical and surgical predictors of neurological outcome after myelomeningocele repair and to assess the role of the Spina Bifida Neurological Score (SBNS) in evaluating preoperative and postoperative neurological status. Identification of factors associated with neurological outcome may help in postoperative assessment, prognostication and optimization of the management of children undergoing myelomeningocele repair.

MATERIALS AND METHODS

A prospective observational study will be conducted among patients with myelomeningocele undergoing surgical repair at a government teaching hospital during the study period. Consecutive patients fulfilling the inclusion criteria will be enrolled after obtaining informed consent, while patients with previous surgery for myelomeningocele will be excluded. Baseline demographic and clinical details, anatomical level of the lesion, relevant radiological findings and preoperative neurological status will be recorded. Neurological function will be assessed using the Spina Bifida Neurological Score (SBNS), including motor function, reflexes and bladder and bowel function. The SBNS will be assessed preoperatively and postoperatively to evaluate neurological outcome.

ABO and Rh blood groups will be recorded from laboratory records and their association with neurological outcome will be assessed. Surgical details including type of defect closure, use of flap, detethering, dural closure technique and intraoperative complications will be documented. Postoperative complications such as CSF leak, wound infection and wound dehiscence will also be recorded.

The primary outcome will be neurological outcome based on the change in SBNS following surgery. Clinical, surgical, radiological and blood-group factors will be analysed for their association with neurological outcome. Appropriate statistical tests will be applied and multivariable regression analysis will be performed to identify independent predictors where appropriate. A p-value of <0.05 will be considered statistically significant. The study will be conducted after approval from the Institutional Ethics Committee, with confidentiality maintained throughout.

RESULTS

A total of 30 patients with myelomeningocele who underwent surgical repair were included in the study. The mean age of the study population was 13.72±17.4 months, with the majority of patients belonging to the 7–12 months age group (40.00%). The study population showed a mild male predominance, with 60.00% males and 40.00% females. The most common anatomical level was lumbar (43.33%), followed by lumbosacral (23.33%) (Table 1).

Blood-group analysis showed that A positive was the most frequent blood group (40.00%), followed by O positive (23.33%) and B positive (20.00%) (Table 2).

The mean preoperative SBNS was 9.93±3.39, while the mean postoperative SBNS was 9.87±3.32. There was no statistically significant difference between preoperative and postoperative SBNS scores (p = 0.326) (Table 3).

Change in SBNS showed that 26 (86.67%) patients had no change, 3 (10.00%) had deterioration and 1 (3.33%) showed improvement (Table 4).

Postoperative CSF leak was observed in 6 (20.00%) patients, whereas 24 (80.00%) patients had no leak (Table 5).

The association between blood group and postoperative CSF leak was not statistically significant (p = 0.384). Although A-positive blood group was more frequently represented among patients with leak, the overall distribution did not reach statistical significance (Table 6).

Table 1: Age Distribution of Study Participants

Age group	Frequency	Percentage
1–6 months	11	36.67
7–12 months	12	40.00
>12 months	7	23.33
Total	30	100

Mean age: 13.72±17.4 months; Median: 8 months (5–11.75)

Table 2: Anatomical Level Distribution

Anatomical level	Frequency	Percentage
Cervical	2	6.67
Dorsal	3	10.00
Lumbar	13	43.33
Lumbosacral	7	23.33
Nasofrontal	1	3.33
Occipital	4	13.33
Total	30	100

Table 3: Blood Group Distribution

Blood group	Frequency	Percentage
A Negative	1	3.33
A Positive	12	40.00
AB Positive	2	6.67
B Positive	6	20.00
O Negative	2	6.67
O Positive	7	23.33
Total	30	100

Table 4: Comparison of Preoperative and Postoperative SBNS

SBNS	Mean±SD	Median (IQR)	Range	p-value
Preoperative	9.93±3.39	11 (9–11)	3–15	0.326
Postoperative	9.87±3.32	10.5 (9–11)	3–15	-

Paired t-test

Table 5: Change in SBNS After Surgery

Change in SBNS	Frequency	Percentage
No change	26	86.67
Deterioration	3	10.00
Improvement	1	3.33
Total	30	100

Table 6: Postoperative CSF Leak

Postoperative status	Frequency	Percentage
No leak	24	80.00
Leak	6	20.00
Total	30	100

Table 7: Association of Blood Group with Postoperative CSF Leak

Blood group	No leak n (%)	Leak n (%)	Total
A Negative	1 (4.17%)	0 (0%)	1
A Positive	7 (29.17%)	5 (83.33%)	12
AB Positive	2 (8.33%)	0 (0%)	2
B Positive	6 (25.00%)	0 (0%)	6
O Negative	2 (8.33%)	0 (0%)	2
O Positive	6 (25.00%)	1 (16.67%)	7
Total	24 (100%)	6 (100%)	30

Fisher's exact test; p = 0.384

Table 8: Association of Rotation Flap with Postoperative CSF Leak

Rotation flap	No leak n (%)	Leak n (%)	Total	p-value
No	17 (70.83%)	6 (100%)	23	
Yes	7 (29.17%)	0 (0%)	7	0.29
Total	24	6	30	

Fisher's exact test

Rotation flap was performed in 7 (23.33%) patients. No statistically significant association was observed between use of rotation flap and postoperative CSF leak (p = 0.29) (Table 7).

Overall, the study demonstrated that most patients showed stable neurological status after myelomeningocele repair, with 86.67% showing no change in SBNS. Blood group A positive was the most frequently observed blood group; however, its association with postoperative CSF leak was not statistically significant. Similarly, neither postoperative CSF leak nor use of rotation flap showed a significant association with change in SBNS (Table 8).

DISCUSSION

Myelomeningocele is associated with variable degrees of neurological impairment and objective assessment of neurological function is important for evaluating postoperative outcome. The Spina Bifida Neurological Score (SBNS) was developed as a quantitative tool incorporating motor function, reflexes and bladder and bowel function, allowing standardized assessment of neurological status in patients with spina bifida [1]. The usefulness of SBNS in postoperative assessment was subsequently demonstrated in children following myelomeningocele repair, where neurological, ambulatory and sphincter outcomes were evaluated [2]. Previous studies have also demonstrated that preoperative and intraoperative factors may influence postoperative neurological outcome after myelomeningocele repair [3]. The importance of standardized neurological and functional assessment was further demonstrated in the Management of Myelomeningocele Study, which evaluated neurological and functional outcomes following different approaches to myelomeningocele management [4]. In the present study, 30 patients were evaluated, of whom 18 (60%) were males and 12 (40%) were females. The majority belonged to the 7–12-month age group. Similar demographic and clinical variability has been reported in previous studies of children with myelomeningocele [5]. The lumbar/lumbosacral region was the most common site of involvement in the present study, accounting for approximately 67% of cases. Previous large studies have demonstrated that neurological level is an important determinant of ambulatory and functional outcome in patients with myelomeningocele [6]. The importance of neurological level and motor function in determining ambulation was also demonstrated in large longitudinal registry-based studies [7]. Hydrocephalus and Chiari II malformation were each present in 10% of patients in the present study. Previous studies have reported a higher frequency of hydrocephalus and have demonstrated its association with neurological and ambulatory outcome [6,8].

The principal finding of the present study was that neurological status remained stable in the majority of patients following repair. Twenty-six patients (86.67%) showed no change in SBNS, while 3 (10%) demonstrated deterioration and 1 (3.33%) demonstrated improvement. The overall difference between preoperative and postoperative SBNS was not statistically significant (p = 0.326). This finding suggested that surgical repair was primarily associated with preservation of pre-existing neurological function in the present cohort rather than significant early neurological improvement [1,2]. The finding was consistent with the concept that the neurological deficit in myelomeningocele is largely determined by the level and severity of the underlying spinal cord lesion. Studies evaluating long-term ambulation have shown that neurological or motor level is strongly associated with functional outcome [6,7,9]. The present study also evaluated postoperative CSF leakage. CSF leak occurred in 6 (20%) patients; however, its association with neurological outcome was not statistically significant (p = 0.28). Previous studies have emphasized CSF leakage, wound complications and infection as important postoperative complications following myelomeningocele repair [10]. The frequency of postoperative complications in the present study was comparable with that reported in previous surgical series. Studies from different clinical settings have reported variable rates of wound dehiscence, infection and CSF leakage following myelomeningocele repair [10,11].

Surgical closure technique was another important factor evaluated in the present study. Muscle flap strengthening was performed in 7 (23.33%) patients. Previous reconstructive studies have supported the use of local and regional flap techniques, particularly for large defects where primary closure may result in excessive tension [12]. Defect size and morphology have also been reported to influence the choice of reconstructive technique [13]. Previous studies have further demonstrated that clinical characteristics and timing of surgery may influence postoperative outcomes [3,14]. More recent studies with larger cohorts have reported associations between age at surgery, lesion site and postoperative outcome, although the relatively small sample size of the present study limited direct comparison [15].

Overall, the findings of the present study supported the use of SBNS as a practical and objective method for assessing neurological status following myelomeningocele repair [1,2]. The predominance of stable neurological scores suggested preservation of neurological function in most patients, while the occurrence of deterioration in 10% emphasized the importance of serial postoperative neurological assessment.

The relatively small sample size of 30 patients was an important limitation and reduced the statistical power to identify independent clinical and surgical predictors. Furthermore, the limited postoperative follow-up restricted assessment of long-term outcomes such as ambulation, bladder and bowel function and late neurological deterioration. Larger prospective studies with longer follow-up and serial SBNS assessment would therefore be required to establish independent predictors of neurological outcome.

CONCLUSION

The present study demonstrated that most patients maintained stable neurological status following myelomeningocele repair, with 86.67% showing no change in SBNS. The overall change in preoperative and postoperative SBNS was not statistically significant ($p = 0.326$), suggesting preservation of pre-existing neurological function following repair. A-positive was the most frequently observed blood group (40%); however, no statistically significant association was found between ABO/Rh blood-group status and postoperative CSF leak ($p = 0.384$). These findings suggest that, within the present cohort, blood-group status was not significantly associated with the assessed postoperative complication. Larger studies with adequate sample size and longer follow-up are required to further evaluate the potential relationship between blood-group characteristics and neurological outcomes after myelomeningocele repair.

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