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ORIGINAL ARTICLE

Early Surgical Management and Outcome in Neural Tube Defects: Experience of A Tertiary Care Paediatric Hospital

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Abstract

Background: *Neural tube defects (NTDs) are significant congenital anomalies resulting from improper closure of the embryonic neural tube, with substantial morbidity and mortality. Timely surgical intervention is crucial in minimizing complications and improving functional outcomes, particularly in low-resource settings.*

Objectives: *This study aims to evaluate the outcome of early surgery in neonates and infants with NTDs and identify postoperative complications.*

Methods: *This prospective observational study was conducted at the Department of Paediatric Neurosurgery, Bangladesh Shishu Hospital & Institute, Dhaka, Bangladesh, from July 2020 to December 2023. A total of 385 neonates and infants with confirmed NTDs (myelomeningocele, meningocele, encephalocele) who underwent surgical repair were enrolled. Data on demographics, clinical features, surgical timing, complications, and functional outcomes were collected and analyzed using SPSS version 26. Logistic regression was used to identify risk factors for complications.*

Results: *Myelomeningocele was the most prevalent defect (72.99%), followed by lipomyelomeningocele (13.51%), with the majority of lesions located in the lumbosacral region (68.83%). Surgery performed within 7 days of birth significantly reduced complications (12.0%) and mortality (2.1%) compared to delayed intervention. Wound infection (33.65%) and new-onset hydrocephalus (25%) were common complications. Delayed surgery, hydrocephalus, and thoracic/cervical lesion location were significant risk factors. At one-year follow-up, 44.94% could walk independently, while 66.75% had neurogenic bladder/bowel dysfunction.*

Conclusion: *Early surgical management of NTDs markedly improves outcomes. Delayed intervention and associated anomalies increase the risk of complications. Strengthening prenatal diagnosis and prompt neurosurgical referral is essential in reducing the long-term burden of NTDs.*

Keywords: *Neural tube defects, myelomeningocele, early surgery, hydrocephalus, postoperative outcomes.*

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Introduction

Neural tube defects (NTDs) represent a group of severe congenital anomalies arising from the incomplete neural tube closure during embryogenesis, typically between the third and fourth week of gestation. Defects such as myelomeningocele, meningocele, and encephalocele are major causes of neonatal illness and death, mainly in low- and middle-income countries.[1,2] Even with improvements in medical care and tests during pregnancy, the global numbers for NTDs are high, according to the World Health Organization, reaching up to 0.5 to 2 per 1,000 births in most parts of the world and even higher in some areas of Africa and Asia.[3,4]

There are many parts to the cause of NTDs, including factors like a person's genes, environment, and what they eat. Among the causes, a lack of folate has been linked most strongly, and research has shown that giving more folic acid or fortifying foods greatly reduces the occurrence of NTDs.[5,6] Even so, many countries lacking fortification laws for folic acid have a high rate of NTDs in South Asia and sub-Saharan Africa.[7] Numerous cases of NTDs still arise in Bangladesh, largely because of poor pregnancy care, poor nutrition, and a lack of health awareness.[8]

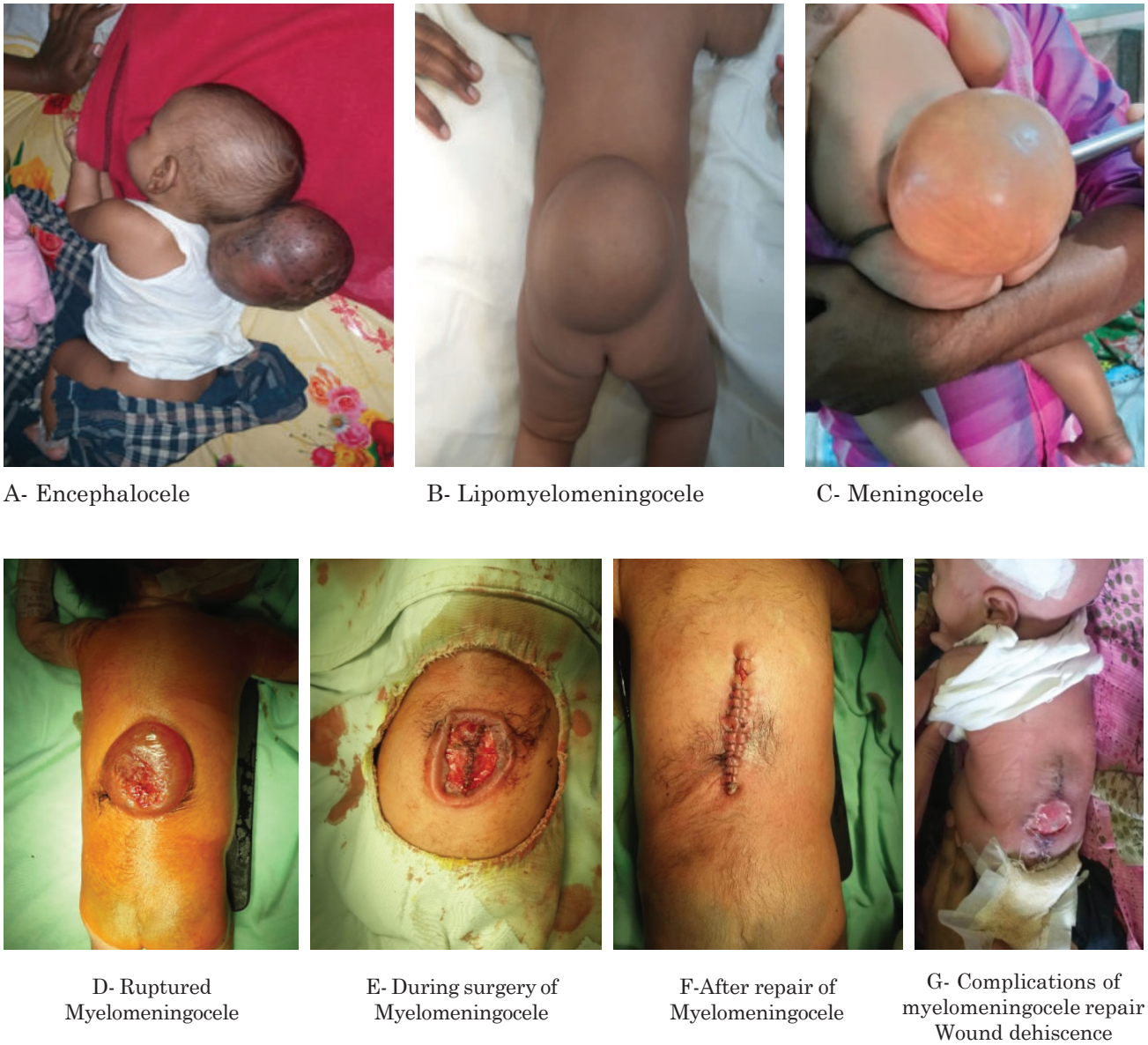
Through ultrasonography and examining blood samples from mothers, various cases of NTDs can be identified early so that people can receive advice and needed treatment.[9] However, antenatal detection is not always good enough in many places, so women often show up too late and have delayed surgery.[10] In most cases, myelomeningocele is especially severe. It usually causes lifelong issues such as lower limbs not working, too much fluid in the brain, and nerve problems related to bladder and bowel function.[11] According to most experts, the preferred treatment for most defects is surgery within the first two days to minimize infection risks, stop any neurological damage, and improve long-term results.[12] Many low-resource settings cannot operate effectively, mainly because of hold-ups in referrals, insufficient well-trained surgeons, and shortages of important resources.[13]

Many studies have examined results from surgeries for NTDs and found that postoperative complications and how patients recover vary greatly. It has been found in Ethiopia and Uganda that wound infection, cerebrospinal fluid leaks, and shunt-related issues occur at high rates in patients.[14,15] How well patients can move and control their bodily functions may depend on the location of the injury, if they have hydrocephalus, and when surgery was performed.[16] At the same time, there is little research from Bangladesh looking at the effects of when surgery is performed and other clinical factors on children's outcomes and recovery after NTD surgery.

This study aimed to explore the effects of operating early for NTDs in babies and infants at a pediatric neurosurgery center in Bangladesh. The study aims to report the complication rate, find risk factors for adverse events, and check the degree of recovery one year after the procedure.

Materials and Methods

This prospective observational study was conducted at the Department of Pediatric Neurosurgery, Bangladesh Shishu Hospital and Institute, Dhaka, Bangladesh, from July 2020 to December 2023. Neonates and infants (<1 year) with confirmed diagnosis of NTD (spina bifida, encephalocele, or myelomeningocele) were included in the study. Patients with lethal anomalies (e.g., anencephaly), lost to follow-up within one-month post-surgery and refusal of consent were excluded from the study. Informed consent was obtained from parents or guardians. Structured case record forms were developed to capture demographic data, clinical presentation, surgical details, and outcomes. Data were corroborated using hospital records and operative notes. On admission, each patient underwent a comprehensive clinical and neurological evaluation. Imaging modalities such as ultrasonography and MRI were used to assess lesion characteristics and associated anomalies. Surgery was performed under general anesthesia, adhering to standardized protocols for defect closure and CSF leak prevention. Follow-up was conducted at one week, one month, and six months post-surgery, focusing on wound status, neurological function, and the presence of complications such as hydrocephalus. Data were analyzed using SPSS version 25. Chi-square and t-tests were employed for inferential analysis. Logistic regression identified predictors of postoperative complications. A p-value of <0.05 was considered statistically significant.



A- Encephalocele

B- Lipomyelomeningocele

C- Meningocele

D- Ruptured Myelomeningocele

E- During surgery of Myelomeningocele

F-After repair of Myelomeningocele

G- Complications of myelomeningocele repair Wound dehiscence

Fig.-1 *Preoperative and postoperative images of Neural Tube Defects*

Results

This prospective study analyzed 385 cases of neural tube defects (NTDs) managed surgically. The mean age at surgery was 9.8±6.7 days. Among the 385 patients, 204(52.99%) were male and 181(47.01%) were female. Myelomeningocele was the most common type of defect, affecting 281 patients (72.99%), followed by lipomeningocele in 52(13.51%), encephalocele in 32(8.31%), and meningocele in 20(5.19%). In terms of defect location, the lumbosacral region was the most frequently involved site (265 cases, 68.83%), followed by the lumbar region (50 cases, 12.99%), the thoracic region (48 cases, 12.47%), and the cervical region (22 cases, 5.71%). Antenatal diagnosis was made in 115 patients (29.87%), and hydrocephalus was associated with 189 cases (49.09%) (Table I).

Table I
Baseline characteristics of patients with neural tube defects (n=385)

Characteristics		Number of patients	Percentage
Mean Age at surgery (days)		9.8 ± 6.7	
Gender	Male	204	52.99
	Female	181	47.01
Type of defect	Myelomeningocele	281	72.99
	Lipomyelomeningocele	52	13.51
	Meningocele	20	5.19
	Encephalocele	32	8.31
Defect location	Lumbosacral	265	68.83
	Lumbar	50	12.99
	Thoracic	48	12.47
	Cervical	22	5.71
Antenatal diagnosis		115	29.87
Associated hydrocephalus		189	49.09

A total of 233 patients (60.5%) underwent surgery within 7 days of birth, and 152(39.5%) had surgery later. Early surgical intervention was associated with significantly lower complication (12.0%) and mortality rates (2.1%) compared to delayed surgery, which had complication and mortality rates of 36.2% and 4.6%, respectively ($p<0.05$) (Table II).

Table II
Timing of surgery and complication rates

Time from birth to Surgery	Patients n (%)	Complications n(%)	Mortality n (%)
≤7 days	233(60.5)	28(12.0)	5(2.1)
>7 days	152(39.5)	55(36.2)	7(4.6)

Among 104 patients who developed postoperative complications, wound infection was the most common (33.65%), followed by new-onset hydrocephalus (25.00%) and cerebrospinal fluid (CSF) leak (20.19%). Shunt malfunction occurred in 11.54% of cases, and meningitis was diagnosed in 9.62%. These data underscore the multifactorial nature of post-surgical morbidity in NTD repair (Table III).

Table III
Types of postoperative complications (n=104)

Complication type	Number of patients	Percentage
Wound Infection	35	33.65
CSF Leak	21	20.19
Meningitis	10	9.62
Shunt Malfunction	12	11.54
Hydrocephalus (new onset)	26	25.00

Table IV identifies variables that significantly predicted postoperative complications. Surgery performed after 48 hours increased the odds of complications (OR=2.3, 95% CI: 1.2-4.1, p=0.01). Hydrocephalus (OR = 1.4, p = 0.04) and defects in the thoracic or cervical region (OR = 1.4, p = 0.02) were also statistically significant risk factors. Lack of antenatal diagnosis showed a trend towards increased risk but did not reach statistical significance (p=0.08).

Table IV
Factors associated with higher complication risk

Factor	Odds Ratio (OR)	CI (Upper-95% lower)	p-value
Surgery after 48 hours	2.3	1.2-4.1	0.01
Hydrocephalus present	1.4	1.0-2.3	0.04
Thoracic/Cervical defects	1.4	0.9-2.2	0.02
No antenatal diagnosis	1.3	0.9-2.1	0.08

Table V details functional outcomes one year postoperatively. 44.94% of patients achieved independent ambulation, while 23.64% required assistance. A total of 15.32% were unable to walk. Bladder and bowel control were preserved in 18.18%, whereas neurogenic dysfunction was present in 66.75%. These outcomes reflect the long-term neurological burden associated with NTDs, particularly when compounded by delayed intervention or associated anomalies.

Table V
One-year functional outcome after surgery

Functional Outcome	Number of patients	Percentage
Walks Independently	173	44.94
Walks with Assistance/ Devices	91	23.64
Unable to Walk	59	15.32
Bladder/Bowel Control Present	70	18.18
Neurogenic Bladder/Bowel Dysfunction	257	66.75

Discussion

This research highlights the results of early surgery for NTDs in newborns and infants at a tertiary pediatric neurosurgical center in Bangladesh. A total of 385 infants took part in the study, and the results suggest that early surgery within the first week after birth significantly reduces postoperative risks, leads to fewer deaths, and improves the child's outcomes.

As seen in our study, myelomeningocele was the leading type of neural tube defect (NTD), affecting 73% of the cohort, followed by lipomeningocele, which was newly identified in 13.5% of patients. The most frequently involved site was the lumbosacral region (68.83%), which contrasts with prior assumptions of lumbar predominance. This observation is similar to what was found in Uganda by Xu et al[14] and in Ethiopia by Getahun et al[17], where pediatric populations mainly had myelomeningocele. Lumbar and lumbosacral spine defects make up the majority of lesions in our study, which agrees with Mekonnen et al[18] and their finding that low spine lesions are cited most often in low- and middle-income countries.

Our study demonstrated that not many pregnancies resulted in a diagnosis made before birth, with antenatal diagnosis amounting to only 29.87%. Even with ultrasonography, very few NTDs are identified early, a difficulty also seen in the communities Melekoglu et al. wrote about, where many women declined to end their pregnancy.[10] More prenatal testing could help make a delivery plan and allow early referral to neurosurgical experts, which may limit complications.

How soon surgery took place was found to have a significant role in postoperative complications and deaths. Those who received surgical care during the first 7 days had far fewer complications (12.0%) and a lower mortality rate (2.1%) than those who underwent surgery afterwards (36.2% complication rate; 4.6% mortality). Our results agree with the findings of Pekta° et al[12] which shows that surgery carried out more than five days after injury can increase the risk of wound infection, CSF leak, and hydrocephalus. Further, Tirsit et al[13] stated that fast surgery following shunt malfunction is connected to better patient results, as it can keep dependence on shunts to a minimum.

This study found that surgery done more than 48 hours after injury, hydrocephalus cases, and abnormalities in the spine are directly related to increased complications. Bowman et al[16] found that higher lesions result in more serious functional disorders and a higher risk of complications. Furthermore, our patients with hydrocephalus, which was found in 49.09%, faced more complications after surgery, a result supported by the studies of Warf et al[15] and Ali et al.[19]

A total of 104 patients (27%) had postoperative complications and wound infection (33.65%), new-onset hydrocephalus (25%), and CSF leaks (20.19%) were the most frequent types. Xu et al[14] and Alatise et al[20] observed the same early morbidity trends as our study. Our findings demonstrate that strict infection control and early CSF diversion measures help reduce these dangers.

One year after bone marrow transplant, the outcomes were a mixture of positive and neutral findings. About 45% of participants gained independent walking, and another 24% could walk with some assistance. Nonetheless, one in seven children was unable to walk, and about two-thirds had bladder and bowel issues caused by the brain. As with the studies of Bowman et al[16] and Gupta et al[21], our findings indicate ongoing physiological and movement issues related to urinary organs, bowels, and legs in children with repaired NTDs. Problems with body functions over the long run are primarily due to where the injury occurred, and if hydrocephalus develops, early care by several specialists is essential.

Researchers found no significant link between antenatal diagnosis and fewer complications ($p = 0.08$). Still, other studies suggest that careful delivery and earlier help for those with prenatal findings can favorably affect results.[22] Even though starting

surgery early can be complicated because of delays and other problems, better community-level prenatal care and referral systems can make a big difference.

Ventriculoperitoneal shunt (VPS) should be integrated when it is indicated. The results in our study match those from Ali et al[19], who showed that prompt placement of a ventriculoperitoneal shunt can stabilize pressure in the brain and prevent neurological worsening in patients with myelomeningocele and hydrocephalus. Still, we noted that shunt malfunction was seen in 11.54% of our patients, so extra attention and access to shunt revision after surgery are necessary.

When we look at previous studies by Addisu et al[23] in Ethiopia and Goswami et al[24] in Pakistan, we here in Kenya have relatively lower complication and mortality rates, likely due to improved treatment and shortened delays. The results vary significantly by region, so different strategies are necessary to help each area.

Overall, this study highlights that when surgery is done early, NTD-affected infants experience less risk of complications and better health outcomes. The study results are consistent with other research in prompt defect closure, treating hydrocephalus, and team follow-up. As many patients continue to face long-term disability, medical teams and families should improve follow-up, education, and access to therapy.

Conclusion

Early surgical intervention in neonates and infants with neural tube defects significantly improves survival rates and functional outcomes while reducing the risk of postoperative complications. This study highlights the critical importance of performing surgery within the first week of life, particularly in resource-limited settings. Delayed surgery, presence of hydrocephalus, and higher lesion levels were associated with poorer prognoses. Despite successful surgical repair, a substantial proportion of patients continue to experience neurogenic bladder and bowel dysfunction, underscoring the need for comprehensive long-term care. These findings reinforce the need for timely surgery and comprehensive multidisciplinary follow-up in improving the quality of life for children with NTDs.

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