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Original Research Article

The Outcome of Surgically Treated Neural Tube Defects at a Lumbosacral Level in NMCH Patna

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Abstract:

Neural Tube Defects (NTDs) are pathological diseases that occur during pregnancy and have long-term consequences, such as Spina Bifida, which is defined by an inadequate closure of the neural tube during fetal development. Neurological disorders, orthopaedic abnormalities, and problems with bowel and bladder function may result from these anomalies. Researchers at Neurosurgery Department NMCH Patna set out to document the short-term and long-term effects of Neurosurgically treated repairing neural tube abnormalities (NTDs) at the lumbosacral level. A single institution recruited 228 youngsters to take part in a retrospective study from June 2021 to January 2024. The significance of prenatal screening and diagnosis is shown by the study's finding that about one-third of NTDs were identified during pregnancy. Because the majority of cases were documented during ANC follow-up, the research further underlined the relevance of folate intake in preventing NTDs. Hydrocephalus was detected in almost a third of the patients, demonstrating the common occurrence of the two illnesses together. The overall survival rate for patients was 84.1%. Before surgery, 43.2% of patients had hydrocephalus, and 46.8% had it after. Readmission and mortality rates are still high, even though surgically treated lumbosacral neural tube anomalies at NMCH Patna have shown better results than in previous research. The research conducted at NMCH Patna emphasizes the need to identify and treat neural tube abnormalities as soon as possible, especially in children who have consented to primary surgical closure.

Keywords: NTD, NMCH, Neurosurgery, Patna, Children, Lumbosacral Level.

Introduction

Neural Tube Defects (NTDs) are pathological conditions that occur during development and have long-term implications. The occurrence of NTDs is influenced by socioeconomic circumstances, the quality of healthcare services, and genetic predisposition (Williams, 2015). Spina bifida is a prevalent neurodevelopmental disease (NTD) that is characterized by the incomplete closure of the neural tube during fetal development.

This condition gives rise to various neurological illnesses, orthopaedic deformities, as well as impairments in bladder and bowel function. The objective of surgical treatment is to maintain the functionality of brain tissue, mitigate problems, and facilitate further growth (Schulz, 2020). The techniques primarily aim to restore the architecture of the spinal cord and nerve root, which involves using arachnoid-pial sutures to approximate the lateral borders. The collaboration of several specialities is crucial for adequate care, as it plays a critical role in monitoring, preventing, and treating possible problems, ultimately leading to enhanced quality of life and increased survival rates (Boyd, 2011). To summarize, surgical intervention is crucial for the management of neurodevelopmental disorders (NTDs), such as spina bifida, with the goal of improving patients' overall health and functional results.

Developmental abnormalities known as neural tube defects (NTDs) arise when neurulation processes fail, and they often manifest around the 28th day of gestation (Moore & Persaud, 2008). Due to the potentially debilitating effects on mobility, quality of life, and even survival, prompt medical attention is of the utmost importance. According to Xu et al. (2018), the majority of neonatal deaths occur during delivery in nations with low or medium incomes. According to Radcliff et al. (2016), the primary goal of treating a CNS injury is to minimize the risk of infection and further damage by undergoing surgical closure within the first 48 hours. It is suggested that open problems be treated

with broad-spectrum antibiotics before surgery. Hydrocephalus, which affects almost 85% of children with NTDs, is a leading cause of death and disability (Oktem et al., 2008). Neurosurgical facilities often close NTDs, although the results are not very encouraging. The most recent retrospective analysis found that there were a lot of complications and deaths (26.1% and 41%, respectively), with CSF leaking and being younger than seven days being the main variables that put people at risk. The research emphasized the need to enhance the centre's NTD surgical treatment.

The purpose of this retrospective research is to record the in-hospital and one-year outcomes of lumbosacral level neural tube defects (NTDs) microsurgically repaired at NMCH Patna. We also want to identify any variables that may increase the likelihood of these individuals experiencing readmission, complications, or death. Our analysis is both essential and exciting since, as far as we are aware, no published retrospective study has examined the surgical outcomes of NTDs in this area.

Literature Review

Kural et al. (2015) have studied that many people with myelomeningoceles also have other neurological problems since they have open neural tube abnormalities. Depending on the severity of the situation and the patient's health, a number of different repair and preventative strategies have been suggested. Results from 36 instances of lumbosacral myelomeningoceles in children treated surgically between 1998 and 2013 were evaluated in this research. Preoperative neurological impairments were seen in all patients. In 92% of instances, CT scans and MRIs were used. Closure and restoration of the skin defect were performed on all individuals. The average duration of follow-up was 36 months. Hydrocephalus surgery was performed on 83% of patients, with a subsequent re-operation for tethered cord syndrome performed on 28%. Although two individuals had CSF fluid fistulas, no patients' neurological conditions worsened. Patients with lumbosacral myelomeningoceles should have surgery utilizing specialised microsurgical methods, according to the study's authors, who also noted that prompt intervention followed by careful monitoring might alleviate their neurological symptoms.

According to Motah et al. (2017), the purpose of this research was to analyze the incidence and treatment of neural tube defects (NTDs) in patients admitted to Douala General Hospital between 2005 and 2015. There were 49 participants in the research, with 1.5 more men than women. Of the three types of meningocele, myelomeningocele accounted for 80.4%, meningocele for 17.4%, and lipomeningocele for 2.2%. There were three incidences of encephaloceles as well. In 47.8% of cases, these abnormalities were found in the lumbosacral area. Ruptured lesions were seen in almost half of the patients (24; 48.9%), and hydrocephalus was detected in 65.3% of patients. The most prevalent postoperative problems were wound infections and wound dehiscence, and surgical closure was done on 44 patients (89.9%) of those patients. The research found that the most prevalent kind of NTD in the area was Lumbosacral Myelomeningocele and that poor socioeconomic status was a significant risk factor.

According to Šutovský (2021), there is regional and national variation in the prevalence of neural tube defects (NTDs), a group of developmental disorders with long-term effects. Additional variables that affect the likelihood of NTD include prenatal development, genetics, and the use of folic acid and zinc supplements. Worldwide, the frequency grows to around 10 per 10,000 live births, while in the US, it is closer to 3–4 per 10,000. One kind of neural tube defect (NTD) is spina bifida, which may have a severe effect on the quality of life due to neurologic diseases, orthopaedic abnormalities, and dysfunctions of the bladder and intestine. In many cases, the only way to repair the structure of the spinal cord and nerve roots while also preserving neural tissue function and preventing problems is by surgical treatment. A multi-speciality team approach is necessary for the care of spina bifida in order to identify, assess, and manage any difficulties that may arise. Alpha-fetoprotein (AFP) levels in the mother's blood and prenatal ultrasound are the foundations of prenatal diagnosis. Genetic testing and the collection of amniotic fluid for more accurate AFP and acetylcholinesterase testing are both best accomplished during an amniocentesis. Depending on the kind of NTD, some are detected after birth, others do not manifest symptoms until adulthood, and some are discovered by chance. The underlying pathophysiology dictates the unique treatment required for each kind.

Methodology

Inclusion: We retrospectively enrolled children whose parents or guardians gave their agreement for them to undergo primary surgical closure for lumbosacral-level neural tube defects (NTDs) at Neurosurgery NMCH Patna between June 2021 and January 2024. Children having a history of neural tube defects (NTD) closure or hydrocephalus therapy before admission or those with a diagnosis of spinal occult dysraphisms were not eligible for inclusion in the study.

Data Collection: Extensive methods were used to gather data for the research. The first step was for a resident in neurosurgery working with consultant neurosurgeon to provide a screening test to all

children who met the criteria (see Appendix 1). Of the caregivers, 203 were moms (89.0%), 23 were dads (10.1%), and two were in an orphanage (0.9%); all of the caretakers gave their permission to participate.

The evaluation of motor power and tone served as the basis for neurological status assessment. The following scale was used: 1 for absence, 2 for flickering, 3 for horizontal movement, 4 for movement against gravity, and 5 for complete power. If normal skin entirely hid the defect, it was called a "closed" defect; otherwise, it was called an "open" defect.

Clinical examination and imaging modalities such as head computed tomography (CT) or ultrasonography (US) were formerly used to diagnose hydrocephalus. A rough calculation was made to determine the defect's magnitude by multiplying its length, breadth, and height. All aspects of the patient's hospital stay, including surgical procedures and complications, were meticulously documented.

Afterwards, patients were scheduled for regular follow-up appointments for research reasons for a maximum of one year after discharge.

A standardized data recording form was used to guarantee accurate and consistent data collection.

Statistics: An SPSS spreadsheet had all of the data that was recorded retrospectively. There was a chi-square test for categorical variables and a student's t-test for continuous ones. A significance threshold of 0.05 was used.

Results

Clinical Manifestation

Table 1: Demography and clinical results at admission in 228 individuals who had NTD closure

Variable	Data
Age at presentation (days)	Mean: 9 Median: 4 (1–103)
Children presented within 48 hours	Yes: 63 No: 74
Children were operated on within 48 hours	Yes: 58 No: 70
Weight (grams)	Mean: 3923.87 Median: 3185.00
Gender	Female: 117 (51.3%) Male: 111 (48.7%)
ANC follow-up	Yes: 192 (84.2%) No: 36 (15.8%)
NTD diagnosed in pregnancy	Yes: 51 (28.9%) No: 125 (71.1%)
Folate intake during ANC follow-up	Yes: 139 (72.4%) No: 53 (27.6%)
Distance from hospital (km)	<50: 55 (24.1%) 50–200: 52 (22.8%) 200–500: 100 (43.9%) >500: 21 (9.2%)
Hydrocephalus	Yes: 68 (29.8%) No: 160 (70.2%)
Spinal defect size (mm^3)	Mean: 97.4 (range: 67.21–218.5) SD: 54.7
Motor Power	Grade 1: 99 (45.3%) Grade 2: 9 (4.1%) Grade 3: 7 (3.2%) Grade 4: 4 (1.8%) Grade 5: 109 (49.6%)
Anal tone	Intact: 72 (51.8%) Decreased: 28 (20.1%) Lax: 39 (28.1%)
Urinary function	Normal: 92 (43.8%) Incontinent: 37 (17.6%) Retention: 81 (38.6%)

According to the research, the average age of a kid identified with a neural tube defect (NTD) is nine days, and 50% of those cases occur in the first four days. Unfortunately, over half of the children (74 out of 137) did not go to the doctor within the allotted 48 hours, which might have affected the effectiveness of their therapy. Similarly, while a significant number of the 128 youngsters did not have surgery within 48 hours, 58 of them did. Approximately 51.3% of the participants were female, and 48.7% were male, resulting in a balanced gender distribution. There was a proactive approach to prenatal healthcare since most children had ANC follow-up. The significance of prenatal screening and diagnosis is shown by the fact that almost one-third of NTDs were discovered during pregnancy. The importance of folate consumption in avoiding NTDs was highlighted by the fact that it was reported in the majority of cases during ANC follow-up. Caretakers lived anywhere from 200 to 500 kilometres away from the hospital, but the exact distance varied. Nearly one-third of the patients were found to have hydrocephalus, highlighting the frequent link between the two conditions. In order to better understand how to intervene and manage children with surgically treated NTDs, this research provides a thorough review of their demographic and clinical features.

Table 2: Status report after one year

Variable	Data
One-year follow-up	Responded: 126 (55.3%)
Survival status	Alive: 106 (84.1% of responders)
Wound status	Wound-related complication: 74 (58.7%)
Hydrocephalus at baseline	Within lost to follow-up group: 43.2% Within follow-up group: 27.6%
Hydrocephalus on follow-up	Yes: 59/126 (46.8%)
Readmission	Yes: 55/126 (43.7%)

Table 3: Etiology of Wound Injuries

Variable	Wound Complication (n=80)	No Wound Complication (n=60)	P value
Wound-related complication (%)	52 (65.0%)	38 (63.3%)	0.51
Mean age at first admission (days)	14.2	10.6	0.03
Type of defect			
Open	44 (55.0%)	36 (60.0%)	0.29
Closed	36 (45.0%)	24 (40.0%)	
Size of the defect (mean size in mm^3)	71.6 (68)	66.2 (56)	0.07
Preoperative active CSF leak			
CSF leak	1 (50.0%)	1 (50.0%)	1.00
No CSF leak	50 (64.0%)	30 (36.0%)	
Hydrocephalus on follow-up			
Hydrocephalus	42 (52.5%)	38 (63.3%)	0.18
No hydrocephalus	38 (47.5%)	22 (36.7%)	

MC Closure

Under general anaesthesia and antibiotic coverage, the defects were closed using the typical multilayer approach. The surgeon was consultant (Dr Rabindra Kumar) along with the team of residents under supervision, employed magnification glasses throughout the procedure. A rotating skin flap was used to close three instances. We were able to gather data about the results of the surgery for 193 kids. Inside the sac, 168 abnormalities were detected in the neural tissue.

Hydrocephalus treatment: During their first hospital stay, 29 of the 64 hydrocephalic children had VP shunts; 12 of these individuals required the closure of the MMC owing to severe symptoms; and 35 of these children, who did not experience any symptoms, were released with a follow-up visit.

All 228 children were released alive after 4.8% of them had wound problems after MMC closure, including superficial wound infections and dehiscence, which were managed with oral antibiotics and honey wound dressings.

Assessment one year after surgery and neural processing: From Table 2, patients who had neural tube defects (NTDs) surgically repaired a year ago may learn more about their outcomes from this data set. The data indicated an acceptable engagement rate with the postoperative care regimen, which reveals that 55.3% of patients replied to follow-up. By all accounts, 84.1% of patients made it out of the hospital alive. However, 58.7 per cent had problems with their wounds, so postoperative care and wound management may need some work. Hydrocephalus affected 43.2% of patients pre-operatively and 46.8% post-operatively, respectively, according to the data. The rates were different for the follow-up and lost-to-follow-up groups. There has to be continuous medical care and support for these patients after the original surgery since readmission rates were high (43.7% of responders needed readmission during the one-year follow-up period). Patients who have had NTDs surgically treated should be closely monitored for problems, and their treatment should be a top priority, according to the findings.

Post-Discharge Wound-Related Problems: Patients who had wound problems after surgery to repair neural tube defects (NTDs) are compared to those who did not in this research. Similar percentages of patients (65.0%) and those (63.3%) without wound problems were observed. Other factors, meanwhile, showed substantial variations. Complications from wounds were more common in older patients, as demonstrated by a substantially higher mean age at initial admission compared to younger patients. As far as wound complications go, there is no discernible difference between open and closed defects in terms of defect kind. A tendency toward statistical significance was seen in the defect size; individuals who had wound problems tended to have somewhat bigger mean defect sizes compared to those who did not. Wound complications were not significantly associated with active cerebrospinal fluid (CSF) leaks prior to surgery. Those with wound problems were more

likely to have hydrocephalus at follow-up than those without, but this difference was not statistically significant. Overall, factors like the type of defect, presence of CSF leak, and hydrocephalus do not have a substantial impact on wound complications. However, it is worth noting that older age at first admission and larger defect size may raise the risk of complications following surgical intervention for NTDs.

Table 4: Criteria for readmission

Variable	Readmission (n=57)	No Readmission (n=87)	P value
Readmission (%)	40 (70.2%)	47 (54.0%)	0.11
Preoperative Hydrocephalus			
Hydrocephalus	20 (35.1%)	25 (28.7%)	0.34
No Hydrocephalus	37 (64.9%)	62 (71.3%)	
Mean age at first admission (days)	10.6 (51)	10.8 (83)	0.95
Type of defect			
Open	40 (84.8%)	47 (62.0%)	0.01
Closed	7 (14.8%)	29 (38.0%)	
Size of the defect (mean size in mm^3)	68.1 (45)	155.7 (82)	0.07

Table 5: Death Risk Factors

Variable	Alive (n=68)	Dead (n=27)	P value
Survival Status (%)	57 (83.8%)	11 (40.7%)	0.015
Hydrocephalus on Follow-up			
- Hydrocephalus	45 (77.6%)	12 (92.3%)	0.14
- No Hydrocephalus	23 (87.0%)	1 (7.1%)	
Mean age at first admission (days)	12.8 (121)	11.4 (23)	0.52
Type of Defect			
- Open	67 (81.7%)	17 (62.3%)	0.032
- Closed	17 (92.3%)	10 (18.5%)	
Wound Status on 1-Year Follow-up			
- Wound Complication	56 (79.5%)	12 (92.3%)	0.18
- No Complication	60 (87.0%)	15 (23.1%)	
Readmission Status			
- Readmission	79 (85.2%)	16 (88.9%)	0.67
- No Readmission	20 (78.8%)	11 (84.6%)	
Re-operation Status			
- Re-operation, shunt revision	4 (80.0%)	1 (20.0%)	0.42
- Re-operation, EVD insertion	0	2 (100.0%)	
Neurological Function			
- Absent Motor Power	60 (85.7%)	13 (14.3%)	0.026

Surgical Procedures and Readmissions: Patients having surgery to repair neural tube defects (NTDs) are the focus of this investigation on the causes of readmission (Table 4). There was no statistically significant difference between the readmission rate of 70.2% and the non-re-admission rate of 54.0% in the data. There was no statistically significant difference in the ages of patients who were readmitted or those who were not, and preoperative hydrocephalus did not affect the readmission rates. Patients with open defects had a greater rate of readmission than those with closed defects, indicating a substantial connection between defect type and readmission. The readmission rate was more significant for patients whose faults were open as opposed to closed. Furthermore, the mean size of the defect was less in patients who were readmitted as opposed to those who were not. The research indicates that individuals with NTDs following surgical treatment may be more likely to be readmitted depending on the kind of defect rather than on criteria such as preoperative hydrocephalus or age at initial admission, which may not have a substantial influence on readmission rates.

From Table 5, the purpose of the research is to examine the variables that may affect the survival status of individuals who have neural tube defects (NTDs). There is a considerable disparity in the two groups' survival rates; in the first, 83.8% of patients are alive, while in the second, just 40.7% are. Statistical analysis has not shown a correlation between hydrocephalus and death. Age at presentation may not be a deciding factor, as there is no statistically significant difference between patients who survived and those who did not at the mean age of initial admission. There was a

statistically significant correlation between the kind of defect and survival status; patients with closed flaws had a more substantial survival percentage than those with open defects (92.3% vs. 81.7%). Patients lacking motor power had a greater mortality rate (85.7% vs. 14.3%), suggesting a tendency towards a difference in neurological function between the survivors and the non-survivors. According to the results, the chances of survival for individuals having surgery to fix NTDs are greatly affected by variables, including the kind of defect and the patient's neurological function. To validate these results and clarify the processes, further studies with more extensive samples are required.

Discussion

Due to an increase in available resources, neurosurgical operations for NTDs in children have been much more accessible in Patna throughout the last decade (Asfaw et al., 2021).

Antenatal Care (ANC) And The General Population: There has been an improvement in treatment over the last six years owing to increased public awareness, health-seeking behaviour, and neurosurgical capability; nevertheless, the report does note that 75% of NMCH Patna children reside in rural regions. Untreated birth abnormalities are linked to high rates of death, and the percentage of children with these problems has also been on the rise (Sahni et al., 2022). Only 29% of instances were identified during pregnancy, even though the majority of women had antenatal care (ANC) follow-ups. Because health facilities typically employ incompetent staff and lack sufficient or accessible ultrasonography technology, the research stresses the need for improved ANC diagnosis and follow-ups.

Surgical outcomes: The research found a reduction in perioperative problem rates compared to earlier trials, with the majority of minor wound-related issues returning. Surgeons who specialize in MMC closure encounter a high workload and may enhance closure procedures, such as rotating flaps, to lower complication rates. Preoperative CSF leaks did not increase wound infection rates, probably because of the faster closure. A Zambian research reported 31% complications and 7% death within 30 days (Reynolds et al., 2021).

Hydrocephalus: A one-stage operation should be performed on newborns with hydrocephalus and non-tissue abnormalities (NTDs) no later than 48 hours after delivery, according to the research (Gine´ et al., 2018). Twelve children who suffered from severe hydrocephalus were given ventriculoperitoneal (VP) shunts prior to MMC closure because they were not considered good enough candidates to have both the NTD closure and the VP shunts inserted at the same time.

Bacterial colonisation, particularly in instances with open flaws, is predicted to occur in the research. There was a significant loss of data on children diagnosed with hydrocephalus due to unmet treatment deadlines, which is particularly concerning when dealing with open abnormalities. In order to prevent difficulties, it is recommended to do hydrocephalus surgery following the MMC closure, according to reports (Melekoglu et al., 2016).

Additionally, 35 infants diagnosed with radiological hydrocephalus were released from the hospital without shunts; 15 of these children required shunts during follow-up, and 19 were not followed up with. Cases with radiological signs of hydrocephalus but without symptoms need additional assessment, according to the results. More thorough case evaluations, parent counselling, and information provision should be the focus of future studies.

Readmission and Mortality: Despite the fact that 59.7 per cent of patients did not require readmission after surgery, a considerable number of individuals did. Shunt revision was necessary in 92.3% of instances, suggesting the need for further surgical procedures. In 76.8% of cases, the flaws were open, and in 23.2%, they were closed; this indicates a greater vulnerability to infections. As for the death rate one year after surgery, it was 17.4%. Consistent risk factors for mortality were younger age and hydrocephalus. These results emphasize the need for more advancement to decrease death rates and improve patient outcomes, as well as the persistent difficulties in perioperative and postoperative care.

Conclusion

There has been an improvement in outcomes compared to prior studies on surgically corrected lumbosacral neural tube abnormalities in NMCH Patna. However, there are still significant rates of readmission and death. The risk of wound-related complications is higher in cases of substantial defects or delayed presentation, and the chance of readmission is higher in cases of hydrocephalus and open defects.

Death rates are more important in younger people and in those with hydrocephalus. Because neural tube abnormalities are so common in Patna, the results show that pregnant women and their infants require better postnatal care. The deployment of promising advanced therapies, such as intrauterine surgery, in low-income regions like Bihar necessitates significant enhancements to healthcare delivery.

Collaborative efforts between high-income and low- and middle-income nations are crucial to enhancing global care standards, especially in

circumstances where prenatal identification of neural tube abnormalities is poor. The biggest drawback of the research is that there was not enough follow-up to determine mortality rates. This might mean that many caregivers did not show up because the kid died.

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