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Original Article

Outcomes of Pediatric Neurosurgical Cases Managed by General Neurosurgeons: A Retrospective Study from Eastern India

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Abstract

Background India is home to almost 19% of the world's children. The burden of diseases in the pediatric age group is quite high and is just the tip of the iceberg. In India, there are very few neurosurgeons who deal with cases in the pediatric age group. Most parents avoid surgical management for their child due lack of confidence in the expertise of the neurosurgeon in handling pediatric cases. Many challenges are encountered in the pediatric population during the pre-, intra- and post-operative period.

Objectives The aim of this study is to study the demographic profile and respective outcomes of pediatric neurosurgical cases (below 18 years of age).

Methods A retrospective study of cases over a period of 1.5 years in the Department of Neurosurgery, Institute of Medical Sciences and Sum Hospital was done. The variables analyzed were age group, sex, diagnosis, elective or emergency, neurological examination, and outcome. Data analysis was done using Version 3.0.2; 2013-09-25 for Statistical Computing (IBM Corporation's SPSS programme, version 27.0, 2020). Literature review was done through the NCBI PubMed, Scopus, Embase, and Google Scholar databases. Quality of life was assessed by the disability-adjusted life years (DALY) score approved by the World Health Organization.

Results The majority of the patients had significant improvement in achieving milestones with reduced morbidity and one case of mortality.

Conclusion To conclude, we have managed all cases of pediatric age group in a general neurosurgery department with utmost skill and meticulous surgery, with less than 0.1% mortality. In the cases that pertain to low resourced centers, areas, and countries where general neurosurgeons are mandated and obliged to perform pediatric neurosurgical procedures, we general neurosurgeons should take it as a challenge to manage these pediatric cases as our study showed appreciable results although the need for specialized pediatric neurosurgical care cannot be overemphasized.

Keywords
- pediatric neurosurgery
- neurological demography
- children
- tumors
- neurosurgery

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Introduction

More than 20% of all diseases in the world are neurological disorders, and the majority of those affected are residents of developing nations. India is home to almost 19% of the world's children. The burden of diseases in the pediatric age group is quite high and is just the tip of the iceberg. Malnutrition, harmful prenatal circumstances, anemia, acquired immunodeficiency syndrome (AIDS), human immunodeficiency virus (HIV), tuberculosis, meningoencephalitis, and demographic changes are the causes of this rising burden.[1] The necessity for developing methods to improve care and ensure uniform patient management has increased due to the rising demand, complexity, and number of neurosurgery patients over the past few years, as well as the ongoing technological advancements in the field. The use of alteplase in ischemic stroke, hypothermia for neuroprotection, improvements in monitoring craniocerebral trauma, and the use of intravascular cooling devices in cases of intracranial bleeding are just a few of the technological and therapeutic advancements that have increased over the past few decades.[2]

Pediatric neurosurgeons treat various types of diseases involving the brain and spine like tumors, congenital developmental anomalies, trauma, etc., in children (<18 years), while the general neurosurgeons treat the bulk of trauma, tumors etc of brain and spine in adult individuals. Compared to adult trauma, craniocerebral trauma experienced by children usually results in less brain damage. The decision-making process for surgical interventions in children differ from that of adults due to the greater malleability of a child's brain. Congenital central nervous system defects are typically lifelong issues and these cannot be fixed by a single procedure. Additionally, the clinical and surgical management of hydrocephalus, which can develop at any age, is far more difficult when it first appears in infancy or childhood. These ailments highlight the distinct surgical difficulties these pediatric patients present.[3]

Therefore, in order to create preventative measures and rapid treatment, it is crucial to be aware of the most common adverse events in children undergoing neurosurgery. This will help lower the morbidity and mortality linked to these procedures. Hence, the present study was done to assess the demographic profile of management of pediatric neurosurgery cases in a general neurosurgery department in an East Indian state.

Methods

Between January 2021 and August 2022, this retrospective study was carried out in the Neurosurgery Department, Institute of Medical Sciences and Sum Hospital, Bhubaneswar, for a group of pediatric patients (age group below 18 years). According to their primary clinical presentation, the patients were divided into a number of groups, albeit there is a significant overlap between these groups. These illnesses were diagnosed clinically, and the results of available neuroimaging facilities and fundamental neurophysiological tests were used to support the diagnosis. As judged necessary, metabolic testing and other pertinent investigations were requested. The only genetic service available is straightforward karyotyping. A few sophisticated genetic tests were done on a research basis. Quality of life was assessed by the disability-adjusted life years (DALY) index approved by the World Health Organization (WHO). Data analysis was done using Version 3.0.2; 2013-09-25 for Statistical Computing (IBM Corporation's SPSS programme, version 27.0, 2020). Literature review was done through the NCBI PubMed, Scopus, Embase, Google Scholar databases.

Results

Most patients were referred by pediatricians and pediatric neurologists; however, some were referred by ophthalmologists, pediatric orthopaedic surgeons, and pediatric surgeons in addition to gynecologists. In all, 236 patients were seen during the study period. Most of the patients who were seen in the neurosurgery OPD for the first time and few presented to us in the emergency department. They were admitted for evaluation and other requirements.

The age of the patients was between 1 day and 18 years. Out of all the patients, 86 (36.4%) were females and 150 (63.6%) were males (►**Table 1**). ►**Table 2** shows the profile of neurosurgical disorders in children. It was seen that most children presented with meningomyelocele (22%) in which lumbosacral meningomyelocele was the most common, followed by conus lipomas (14.4%), brain and spine tumors (12.7%), hydrocephalous (11%), and head trauma injuries (9.7%). It was found that among tumors, most of the children had posterior fossa tumors, followed by cerebellopontine and other cranial/spinal tumors. They were categorized into four groups according to their age (►**Table 3**): neonates, infants (excluding neonates), >1 to 5 years, and >5 to 18 years of age. We had 18, 50, 50, and 118 patients, respectively, in the four groups. Also, an analysis of the most common neurological pathology of disorder versus age of presentation showed that meningomyelocele was most common during infancy; conus lipoma and hydrocephalus were also common in infants. Central nervous system (CNS) tumors were common in the >5 to 18 year age group. The rest of the details are available in ►**Table 4**. We had one patient of thoracic tail, which was the world's first reported case. Few images of critical cases operated on by us are shown in ►**Fig. 1**. Most patients

Table 1 Demographic characteristics

Variables ($n = 236$)	
Age	
Range	1 d–18 y
Gender	
Male (%)	150 (63.6)
Female (%)	86 (36.4)

Table 2 Diagnosis of neurological disorder

Variables ($n = 236$)	*N* (%)
Meningomyelocele	52 (22.0)
Conus lipoma	34 (14.4)
Tumors (benign + malignant)	30 (12.7)
Congenital hydrocephalus	26 (11.0)
Trauma (EDH, SDH, SAH, ICH: for decompressive craniectomy/cranioplasty)	23 (9.7)
Hydrocephalus due to secondary cause	10 (4.2)
Spinal trauma	9 (3.8)
Split cord malformation	8 (3.4)
Depressed skull fracture	8 (3.4)
Shunt displacement/shunt block	7 (2.9)
Scalp swelling/wound dehiscence	7 (2.9)
Craniosynostosis	6 (2.5)
Caudal regression syndrome	4 (1.7)
Vascular malformation of brain	3 (1.2)
Spinal abscess	3 (1.2)
IIH	3 (1.2)
CVJ anomaly	2 (0.8)
Thoracic tail	1 (0.4)

Abbreviations: CVJ, craniovertebral junction; EDH, epidural hematoma; ICH, intracranial hemorrhage; IIH, idiopathic intracranial hypertension; SAH, subarachnoid hemorrhage; SDH, subdural hematoma.

Table 3 Age-wise distribution of pediatric patients visiting neurosurgery department

Age distribution of pediatric neurosurgery cases			
Neonates	Infants (excluding neonates)	Age >1–5 y	Age >5–18 y
18	50	50	118

were shifted to the neurosurgery ward after surgery, with an observation period of 6 hours postsurgery except for a few patients of trauma and brain tumors. Mortality occurred in only one patient, which was due to postoperative intractable seizures. The rest of the patients recovered with grossly normal milestones achieved later in life, and thus minimal morbidity. The DALY score was below 1 in 97% cases and below 2 in 99.9% cases.

Discussion

Children's neurological diseases are frequently referred to tertiary care hospitals. More than 20% of all diseases in the world are neurological disorders, and the majority of those affected reside in developing nations.[1] In high-income nations, pediatric developmental medicine and childhood neurology are well-established disciplines where improvements in diagnostic methods have helped characterize and define disease. The use of contemporary therapy techniques has produced noticeably better outcomes.[4]

It was discovered that the male predominance was consistent with our local statistics.[5–7] The authors are unsure if this ratio represents the population's cultural bias in favor of men. The age of the patients seen in the clinic ranges from 1 day to 18 years.

For many of the impacted youngsters, specialist care, rehabilitative assistance, and interdisciplinary teamwork are required. Despite the significant prevalence of spinal dysraphism, no institutions exist to provide these patients with the proper care. Surgical procedures including repairs of spinal dysraphism, intracerebral brain tumors and shunting procedures for hydrocephalus are the three pediatric operations with the highest rates of complications. The complications that are reported the most frequently are infections, cerebrospinal fluid (CSF) leakage, and respiratory complications like apnea, sepsis, and death. Cephalosporins, particularly those of the second generation, should be administered as prophylactic for 48 to 72 hours before elective neurosurgeries because they are potentially contaminated procedures. If the patient had seizures before the procedure, antiepileptic medications must be prescribed in the early postoperative period.

Role of Anesthesia and Pediatrician Support

All the pediatric patients are operated on under general anesthesia. Based on local observations and operation theater records, we broadly documented the following experiences. The induction of anesthesia in babies are quite different than adults. They have a difficult intravenous access. The babies are at risk during the period of general anesthesia due to a short apnea period, which leads to rapid desaturation. Laryngoscopy

Table 4 Age versus neurological pathology of presentation

Age range vs. pathology				
Disease	Neonates	Infants	>1–5 y	>5–18 y
Myelomeningocele	37.5%	50%	12.5%	0
Conus lipoma	0	62.5%	12.5%	25%
Intracranial tumors	0	2%	24%	74%

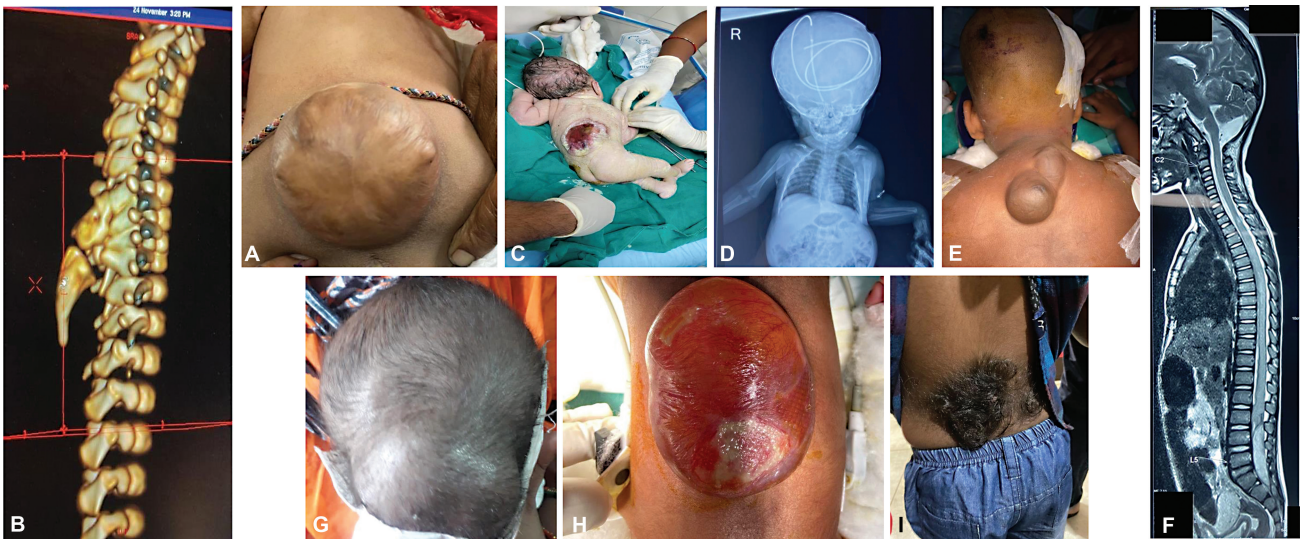

Fig. 1 Images of few critical cases operated on by the authors. (**A**) Conus lipoma. (**B**) a case of thoracic tail. (**C**) Ruptured meningomyelocele. (**D**) Intracranial migration of ventriculoperitoneal (vp) shunt. (**E**) Bilobed meningomyelocele. (**F**) case of spinal tuberculosis with abscess. (**G**) Occipital encephalocele. (**H**) Meningomyelocele. (**I**) Case of split cord malformation with a tuft of hair.

and airway access are quite difficult in pediatric patients. We also noted that they are more prone for hypothermia, hypoglycemia, and fluid overload. There is a higher chance of bronchospasm and laryngospasm during extubation and a higher chance of airway obstruction postextubation. So they need constant critical monitoring during the surgical phase and even after that. Here in our hospital, we have a dedicated pediatric anesthetist for all the pediatric neurosurgery cases. All the babies who undergo elective surgery are extubated postsurgery and kept in recovery for 4 to 6 hours of observation and shifted to their respective single cabins where they are monitored by a dedicated nurse. We have not shifted cases to any intensive care unit (ICU) 99% of the time. However, babies who were operated on under emergency with trauma or in a low condition who were not extubated are monitored in the pediatric or the neonatal ICU for a few post-op days.

The role of the pediatrician comes from the preoperative period itself where they evaluate the babies for fitness regarding surgery, drug dose monitoring, and pediatric and neonatal ICU critical care if needed.

Technical Nuances of Operating a Pediatric Patient

Despite much progress, surgery in the pediatric age group, particularly the cranial and spinal surgery, remains a challenge for the neurosurgeon due to its complex anatomy. More so in congenital anomalies and tumors, a great technical expertise plays a very important role in minimizing morbidity in pediatric patients, positively. We noted that if the following basic nuances are addressed well, there will be maximal success in pediatric neurosurgery with no significant sequalae, thereafter:

- Selecting appropriate pediatric-specific set of instruments.
- Choosing small-size sutures like 3–0, 4–0, and 5–0.
- Ensuring minimal skin incision possible
- Aiming minimal possible blood loss with strict and complete hemostasis to be achieved, starting from skin to within
- Understanding and studying in detail the operative anatomy prior to surgery.
- Meticulous handing and closure of tissue layers.
- Utmost asepsis (pre- and post-op).

Conclusion

According to this study, our community is well represented across the entire spectrum of childhood neurosurgical diseases. To conclude, we have managed all cases of pediatric age group in a general neurosurgery department with utmost skill and meticulous surgery, with less than 0.1% of mortality. In the cases that pertain to low resourced centers, areas, and countries where general neurosurgeons are mandated and obliged to perform pediatric neurosurgical procedures, we general neurosurgeons should take it as a challenge to manage these pediatric cases if it is not possible to refer them to other tertiary centers as our study showed appreciable results of managing these cases with minimal infrastructure. However, the need for specialized pediatric neurosurgical care cannot be overemphasized. Where there is specialist care available, their consult would be of immense value.

Authors' Contribution

A.A. is the main author of the current article, and he compiled the images. S.B.S. was responsible for the methods and review of literature. S.P. was responsible for compilation of data. A.M. was responsible for discussions

and technical nuances. The Manuscript has been read and approved by all the authors and the requirements for authorship has been met and each author believes that the manuscript represents honest work.

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Conflict of Interest
None declared.

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