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Original Research Article

Study of clinico-etiological profile and outcome of operated children of hydrocephalus in a tertiary care hospital

Arpita Adhikari*, Aishwarya Parmare, Veluru Nithin, Mona P. Gajre

Lokmanya Tilak Municipal Medical College, Mumbai, Sion, Maharashtra, India

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***Correspondence:**
Dr. Arpita Adhikari,
E-mail: arpitathakker@gmail.com

ABSTRACT

Background: Hydrocephalus is a prevalent neuro-pediatric condition associated with considerable morbidity and mortality. Ventriculo-peritoneal (VP) shunt placement remains the standard treatment, although complications are frequent. This study evaluated the clinico-etiological profile and outcomes of children with hydrocephalus who underwent VP shunt surgery at a tertiary care hospital.
Methods: A bidirectional study was conducted involving 52 children aged 1 month to 12 years who underwent VP shunt surgery. Demographics, clinical features, etiologies, imaging, surgical procedures, and outcomes were analyzed. Follow-up assessments were performed at 3, 6, 12, and 24 months to evaluate complications, clinical outcomes, and psychosocial impact.
Results: A female predominance was observed (male to female ratio=0.8:1), with most children presenting at a mean age of 3.7 years. Seizures (55.8%) and progressive head enlargement (28.8%) were the most common presenting features. Acquired hydrocephalus (65.3%) was more prevalent than congenital hydrocephalus (32.6%), with tuberculous meningitis identified as the leading cause (50%). Dandy-Walker malformation was the most frequent congenital etiology (21.1%). Communicating hydrocephalus was the predominant type (80.8%). The most common complications were shunt blockage (51.9%), infection (40.4%), and migration (40.4%). Overall mortality was 34.6%.
Conclusions: In this cohort, pediatric hydrocephalus was predominantly acquired, with tuberculous meningitis as the leading cause. VP shunt surgery improved survival but was associated with high rates of complications and revisions, particularly among younger children and those with tuberculous meningitis. Long-term morbidity included growth impairment and psychosocial challenges. Early diagnosis, regular follow-up, and prompt management of shunt complications are essential for improving outcomes.

Keywords: Hydrocephalus, Ventriculo-peritoneal shunt, Tuberculous meningitis

INTRODUCTION

Hydrocephalus refers to a disorder of cerebrospinal fluid resulting in abnormal expansion of cerebral ventricles, typically associated with increased intracranial pressure and related consequences.[1]

Hydrocephalus is a relatively common neuro-pediatric condition, with an incidence of about 0.2 to 0.5 per 1000 births.[2] The prevalence of hydrocephalus in pediatric population varies from 30 to 423 per 100,000 pediatric population in various reported studies, with prevalence being higher in developing nations.[3]

Obstructive hydrocephalus is caused by an obstruction of CSF drainage by a tumor, congenital defect, or infection. Most cases of hydrocephalus are obstructive. Communicating hydrocephalus is caused by an overproduction of CSF that allows insufficient drainage time, or occurs when CSF is not absorbed at normal rate.

The pathophysiology of hydrocephalus is much more complex than its clinical or radiological presentation, going beyond the ventricular dilatation and mantle thinning.

In addition to gross macroscopic changes, hydrocephalus alters the normal physiology, biochemistry, and ultrastructure of the brain. Three factors are basic to determining the severity of injuries caused by hydrocephalus and the ultimate outcome: age at onset, etiology, and disease duration.

The standard treatment for hydrocephalus is shunt placement. The most common drainage site is the peritoneum, which is connected to the shunt with subcutaneous tubing. This is known as a VP shunt.

VP Shunt has greatly improved the survival in a child with hydrocephalus but malfunctioning of shunt is a common problem experienced by children after VP shunt.

The purpose of this research is to provide a complete and updated panel useful to recognize and characterize the broad spectrum of clinical manifestations and etiology of hydrocephalus, its outcome after VP shunt surgery and its demographic distribution in the pediatric age group.

Aim

Aim of the study was to study of clinico-etiological profile and outcome of operated children of hydrocephalus in a tertiary care hospital.

Objectives

Objectives to assess the clinico-etiological profile and demographic distribution of children with hydrocephalus in the age group of 1 month to 12 years, to assess the outcome of hydrocephalus in children aged 1 month to 12 years who underwent VP shunt surgery, to correlate between the clinico-etiological profile and the outcome after VP shunt and to assess the complications of VP shunt surgery over a period of 2 years.

METHODS

Study setting and design

This is a retrospective and prospective (Bidirectional study) done in Pediatric OPD and Wards in Lokmanya Tilak Municipal Medical College and Hospital, Mumbai (LTMMC and GH).

Sample size

Sample size of 52 was determined using SAS 9.2 package based on the study of clinico-etiological profile and outcome of operated children of hydrocephalus in a tertiary care hospital by Ahmed et al.[4]

Efficacy variable

Occurrence of complications

Null hypothesis H0

Occurrence of complications was 50.0 percent.

Alternative hypothesis H1

Anticipated occurrence of complications were 69.0 percent.

Minimum sample size was 52, power-80% and alpha=0.05.

Statistical test Z test for binomial proportion.

Inclusion criteria

Children aged 1 month to 12 years who underwent VP shunt surgery for hydrocephalus during period of January 2017 to December 2019 were included in the study.

Exclusion criterio

Patients/parents not giving consent for participation in the study were excluded from the study.

After obtaining approval from institutional ethical committee (MUHS-038899/2019) from LTMMC and GH, Sion, all consenting patients aged 1 month to 12 years who underwent Shunt Surgery for hydrocephalus during the period of January 2017 to December 2019 were recruited in the study. They are telephonically interviewed on the basis of predesigned case record form after taking verbal consent. A well written informed consent taken from the caretaker/parents/guardian of all children and assent form filled for children wherever applicable. A structured case record form containing all the necessary details was filled by the investigator. Demographic details including age, gender and socioeconomic status as per modified Kuppuswamy scale were recorded. Detailed history, clinical examination findings, anthropometry and investigations done at the initial presentation before operation collected from the existing records and noted in a pre-designed case record form. Complications after VP shunting if any were also recorded. The child was followed up on his/her OPD visits and findings and blood investigations (if any) noted for period at 3 months, 6 months, 1 year and 2 years post-surgery. Special investigation and radiological investigations done subsequently post-surgery are also noted. Data was analysed using SPSS V15.0 package.

RESULTS

In our study, females were more than males i. e., there is female predominance in pediatric hydrocephalus (M:F=0.8:1). Majority of children were in age group of 1-

6 years with mean age of 3.7 years at presentation (Table 1).

Most of them were belonging to lower lower socioeconomic strata. In our study, seizures (55.8%) and progressive increase in head size (15%) were common presentation in children with hydrocephalus. Headache (75%) was significantly common symptom in elder children (>6 years age group) and increase in head size (41.7%) in those who had congenital hydrocephalus (<1 and 1-6 years age group) (Table 2).

In our study, prevalence of acquired hydrocephalus (65.3%) was more than congenital hydrocephalus (32.6%). Of the cases of acquired hydrocephalus, tuberculous meningitis was the most common etiology. The children with tuberculous meningitis presented predominantly in the age group of 1-6 years and the most common presentation was seizures in 81.4% children. Pilocytic astrocytoma was most common neoplastic cause of acquired hydrocephalus. Dandy walker malformation (21.1%) was most common etiology of congenital hydrocephalus. The children with Dandy walker malformation presented predominantly in the age group of <1 years and 1-6 years and increase in head size was the most common presentation (Table 3).

In majority of patients (53.8%), MRI brain with contrast neuroimaging was done for evaluation of hydrocephalus and most common type was 'communicating' as per neuroimaging reports (80.8%). Majority of children were operated at less than 1 year of age (median age of shunt placement was 3.6 years) and most common type of CSF diversion surgery done was medium pressure VP shunt insertion (98.1%). In our study both medium and low pressure VP shunt had similar outcome and shunt complication post insertion. We observed that patients who had high CSF protein had EVD insertion followed by delayed shunting as a temporary measure employed until CSF protein levels decreased. Hydrocephalus is associated with multiple complications on follow up. Shunt blockage (51.9%) was most common complication post VP shunt surgery followed by shunt infection (40.4%) and shunt migration (40.4%). The children in the age group of 1-6 years had maximum shunt related complication. Shunt blockage was more common in children with tuberculous meningitis (58.8%) and shunt infection was more common in dandy walker malformation (41.4%) (Figure 1).

Majority of children required shunt revision once and were predominantly in age group of 1-6 years (71.9%). Hydrocephalus associated with tuberculous meningitis required multiple shunt revisions. We observed that interval between initial and revision surgery was 12-24 months in majority of study subjects. Growth affection was most common clinical outcome in 23.5% children with dandy walker malformation and 38.2% children with tuberculous meningitis. School drop was most common psychosocial outcome in 27.2% children with dandy walker malformation and 17.6% children with tuberculous meningitis. We observed that children with hydrocephalus who were operated developed undernourished nutrition status as per anthropometric data on follow up. These complications could be due to the shunt related complications (such as shunt infection and shunt blockage where children had to undergo multiple revisions). In our study disease specific (82.3%) mortality was more than the mortality associated with shunt complications (17.6%) (Figure 2).

Table 1: Distribution of study subjects according to the age and gender, (n=52).

Age (in years)	Male, N (%)	Female, N (%)
≤1	4 (17.4)	8 (27.6)
1-6	17 (73.9)	15 (51.7)
>6	2 (8.7)	6 (20.7)

Table 2: Distribution of study subjects according to signs and symptoms at the time of presentation.

Variables	N	Percent (%)
Symptoms		
Seizures	29	55.8
Vomiting	23	44.2
Headache	13	25.0
Fever	15	28.8
Excessive irritability/ lethargy	18	34.6
Refusal of feeds	6	11.5
Signs		
Increase in head size	15	28.8
Sunset sign	11	21.2
Cranial nerve palsy	4	7.7
Double vision/ loss of vision	1	1.9

Table 3: Distribution of study subjects according to etiology.

Etiology	N	Percent (%)
Congenital	18	32.6
Aqueductal stenosis	3	5.7
Arnold Chairi malformation	3	5.7
Dandy walker malformation	11	21.1
Porenchephalic cyst	01	1.9
Acquired	34	65.3
Tuberculous meningitis	26	50.0
Neoplastic	2	3.8
Post pyo-meningitis	2	3.8
Cystic encephalomalacia	2	3.8
Intra-ventricular haemorrhage	2	3.8

Shunt related mortality was higher in age group of 1-6 years (6.3%) and disease specific mortality was predominantly in age group of 6-12 years (75%). In children with tuberculous meningitis there was mortality due to both disease and shunt related complications. This

observation can be due to overall poor general condition and malnourished status of these children.

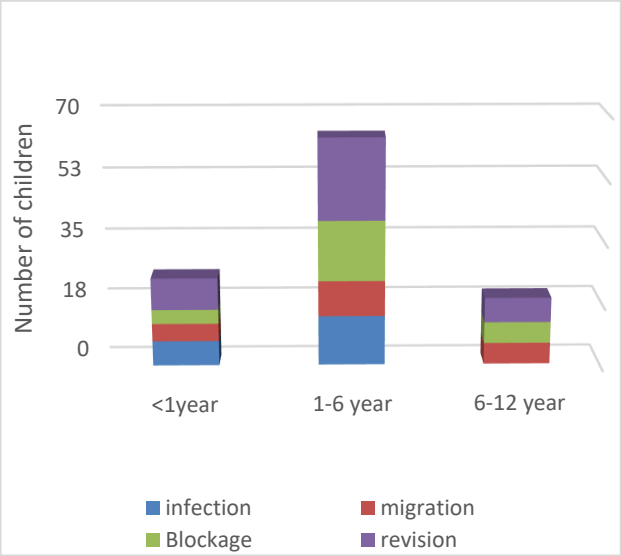

Figure 1: Association between age and shunt related complications.

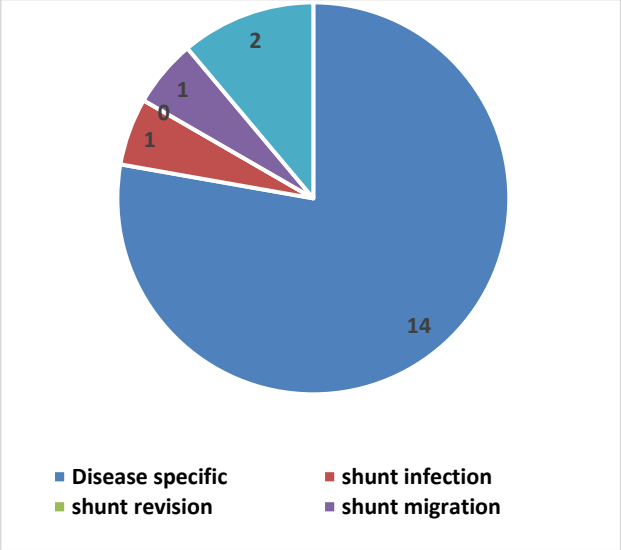

Figure 2: Distribution of study subjects according to mortality.

DISCUSSION

Demographic details

In our study out of 52 children, 23 (44.3%) were males and 29 (55.8%) were female. The male to female ratio observed was 0.8:1. Highest prevalence of children with hydrocephalus was seen in age group of 1-6 years with mean age of 3.7 years at presentation. This can be explained by fact that congenital hydrocephalus and infantile hydrocephalus are usually diagnosed early because of their obvious clinical presentation. In our study out of 52 patients, 78.8% patients had appropriate development for age on presentation whereas 21.2% patients had delayed development on presentation itself.

Signs and symptoms on presentation

Children with hydrocephalus had multiple symptoms on presentation of which most common symptom was seizure in 55.8% followed by vomiting in 44.2% children. Most common signs were progressive increase in head size (28.8%) and sun setting of eyes (21.2%). These findings were comparable to the study done by Singh et al who found seizures in 23.1% children, progressive increase in head size in 31.6% children which was most common sign.[5]

Headache was significantly common presentation symptoms in 75% children of >6 years age group (p=0.001), this is because clinical manifestation depends upon status of cranial sutures and fontanels, before the closure child mainly presents with increase in head size, after closure chief presentation is related to raised intracranial pressure.

Etiology

In our study overall most common cause of pediatric hydrocephalus was tuberculous meningitis in 50% study subjects followed by dandy walker malformation in 21.1% children. Amongst congenital variety most common cause was dandy walker malformation in 11 out of 18 children followed by Chiari malformation and aqueductal stenosis in 3 study subjects each.

Maximum study population in our study were children with hydrocephalus associated with tuberculous meningitis because of high prevalence and we being tertiary referral center. We had only 2 children who had neoplastic etiology. We found that posterior fossa pilocytic astrocytoma was most common neoplastic etiology causing pediatric hydrocephalus. Worldwide post infectious hydrocephalus is most frequent etiology of neonatal and pediatric hydrocephalus, similar findings were observed in study conducted by Warf et al.[6] In below 1 year age group most of study subject had congenital hydrocephalus (58.3%), tuberculous meningitis was most common in age group of 1-6 years (n=15) followed by 6-12 years (n=7). In study conducted by Singh et al below 1-year maximum study subject had congenital hydrocephalus, neoplasm was common in 1-6 years age group. Maximum children above 6 years had post infectious hydrocephalus.[5]

When symptoms were compared with etiology, amongst children with congenital hydrocephalus, 28.6% presented with lethargy/irritability, increase in head size was significantly common symptom in 71.4% (p=0.001). Similarly, amongst children with acquired hydrocephalus who had tuberculous meningitis most common presentation symptom was seizure in 81.4%, headache in 42.3%, vomiting in 65.4% children. Both patient who had

neoplastic etiology presented with lethargy/irritability and vomiting. Overall seizures, headache and vomiting were significantly common presentation symptom (p=0.037, 0.023, 0.001 respectively).

Investigations for evaluation of hydrocephalus

MRI brain with contrast done in 53.8% patients followed by CT brain with contrast in 44.2%. USG skull was done in only 1 patient with congenital hydrocephalus. In a research study conducted by Krishnan et al and Dincer et al it was found that MRI brain was best modality for radiological evaluation of pediatric hydrocephalus.[7,8] On categorizing study subjects into type of hydrocephalus based on neuroimaging reports, out of 52, maximum patients i. e., 42 had communicating type and only 10 had non communicating hydrocephalus.

Shunt related complications in operated children of hydrocephalus

In our study we followed up operated children of hydrocephalus at discharge, at 3 months ,6 months, 1 year and 2 year post surgery for shunt related complications, clinical outcome and psychosocial outcome.

We found that when study subjects were followed up post CSF diversion procedure, they had multiple complications on follow up of which most common shunt related complication was shunt blockage in 51.9% children, followed by shunt infection and shunt migration in 40.4% study subjects. About 75% (n=39) children required shunt revision after initial surgery on follow up.

In a similar study conducted by Singh et al most common shunt related complication was also shunt obstruction (11.6%) followed by shunt infection (5.8%).[5] In another study conducted by Pan incidence of shunt revision was 27%, shunt blockade 45.94%, shunt infection 16.21%, shunt migration 10.81%, and shunt malfunction due to abdominal pseudocyst 10.81%.[9] Similar study reported that the incidence of shunt failure was highest in the first 6 months following the VP shunt. The incidence of complications following VP shunt placement is reported to be around 20-40%. However, Stone et al reported 84.5%.[10] On correlating age with shunt related complications in different age groups, shunt infection was significantly (p=0.028) higher in 1–6-year age group followed by less than 1 year. Children in age group of 1-6 had maximum shunt migration, shunt blockage and revision.

In our study most common shunt related complication in congenital hydrocephalus was shunt infection (p=0.016) with high incidence in 41.4% (n=7) children who had dandy walker malformation. Shunt malfunction and shunt infection are reported as the commonest complication after shunting in dandy walker malformation in study conducted by Bokhari et al.[11]

Also shunt blockage (29.4%), shunt migration (35.2%) and shunt revision (41.4%) was observed maximally in children with dandy walker malformation. Two children who had congenital hydrocephalus developed epilepsy on follow up. Growth affection was maximum in 23.5% operated children of hydrocephalus who had dandy walker malformation. Vision and hearing impairment found in only one patient.

In our study, in children with acquired hydrocephalus most common complication post shunt was shunt blockage, significantly higher in children with tuberculous meningitis (58.8%, p=0.037). Shunt infection found in 2 children with cystic encephalomalacia; however, it was rare complication in children with TBM (5.8%). Shunt revision rate was significantly higher in acquired hydrocephalus due to TBM (70.5%) (p=0.001).

Overall shunt related complications were maximum in children with tuberculous meningitis amongst acquired variety. The reasons for this are the poor general condition of these patients and also the presence of higher protein and cellular content in the CSF leading to more frequent shunt obstruction.

Agarwal et al reported shunt related complications in 30% children with TBM. Palur et al reported that 26 of 114 (22.8%) patients had to undergo one or more shunt revisions, one patient requiring more than three revisions.[12,13] Sil and Chatterjee reported a shunt infection rate of 15.6% and revision rate of 43.8% in their series of 37 children who underwent shunt surgery for TBM with hydrocephalus.[14]

In a research study conducted by Sabeti et al prematurity was one of the risk factors for shunt infection.[15] However in our study, on correlating shunt infection with gestational age in children with congenital hydrocephalus, on follow up it was found that shunt infection is more amongst one who delivered at term (44.4%) and only 5 preterm children had shunt infection on follow up.

Treatment of hydrocephalus

In our study maximum of 44.2% were operated at less than 1 year of age, 40.4% between 1-6 year of age and 15.4% were operated after 6 years of age. Median age of shunt placement was 3.6 years. In a study conducted by Pan it was observed that the median age of the patients at the time of VP shunt placement was 20.7 months.[9] In our study most common type of CSF diversion surgery done for addressing hydrocephalus was medium pressure VP shunt insertion in 65.4% patients, 32.7% children underwent low pressure VP shunt insertion. Only 1 child had Omaya reservoir insertion. Out of 52 children with hydrocephalus, 17 required EVD insertion followed by delayed shunting. In our study we observed that patients who had high CSF protein more than 100 mg/dl had EVD insertion followed by delayed shunting. This is because

patients with increased protein levels in CSF are at a high risk of VP shunt blockage. In these patients, temporary measures should be employed until CSF protein levels decrease. Similar findings were concluded in a retrospective study conducted by Kamat and Gretschel which was carried out on 214 children who underwent VP shunt insertion for Tubercular meningitis.[16]

Shunt revision

Out of 39 patients who required shunt revision, 27 children required revision once, twice in 11 and thrice in only one study subjects. On correlating age with shunt revision as a complication, maximum children requiring shunt revision were in age group of 1-6 years followed by less than 1 year age group. When etiology was correlated with number of revision required after initial surgery, maximum children with tuberculous meningitis required shunt revision. Maximum children required revision between 12-24 months after initial surgery, only 1.9% children required shunt revision within initial 3 months after surgery.

Clinical outcome after VP shunt surgery

In our study, when operated children of hydrocephalus were followed up in terms of clinical outcome, at the end of last follow up (after 2 years of initial surgery) 11.5% (n=6) children developed epilepsy on follow up, and 9.6% developed vision and hearing loss. In our present study, it was found that 32.7% children had significant growth affection when compared anthropometrically with pre shunt growth. 46.1% children found to be unaffected in terms of clinical outcome.

In 18 children with congenital hydrocephalus, on follow up, two children developed epilepsy out of which one had aqueductal stenosis and other one had dandy walker malformation.

Growth affection was maximum in 23.5% operated children of hydrocephalus who had dandy walker malformation. Vision and hearing impairment found in only one patient. Overall incidence of impaired clinical outcome was more in children who had dandy walker malformation postoperatively.

Amongst acquired etiology, 23.5% children with tuberculous meningitis had epilepsy on follow up, growth affection was also maximum in children with tuberculous meningitis, 11.6% with tuberculous meningitis also had vision and hearing impairment. Overall incidence of impaired clinical outcome was observed more amongst post op children with tuberculous meningitis.

Psycho-social outcome

When study subjects who underwent shunt surgery were analyzed for psychosocial outcome on follow up (after 2 years of initial surgery) 42.3% had school drops and 44.2% had delayed developmental milestones (as per history and examination findings) when compared with pre surgery development. The 13.4% children found to be unaffected in terms of psychosocial outcome.

Similarly in study conducted by Singh et al psychosocial morbidity was significantly high in age group of 1-6 years and 6-12 years.[4] School drop rate was 29%, 18% children had developmental delay. In our study, school drops (41.4%) and developmental delay (47%) were common amongst children with dandy walker malformation. Incidence of delayed development was significantly high on follow up in children with congenital hydrocephalus (p=0.029).

Overall high incidence of shunt related as well as clinical and psychosocial morbidity found to be more in postoperative children with dandy walker malformation similar to the findings of Rahul et al.[5]

Amongst acquired variety, developmental delay (14.7%) and school drops (17.6%) found to higher in postoperative children with tuberculous meningitis.

On correlating shunt related complication with clinical outcome, maximum of those who had shunt revision developed epilepsy (11.7%), and growth affection (23.5%). Growth affection was significant clinical outcome in those who had shunt related complications (p=-0.038).

Mortality

In our study out 52 children operated for hydrocephalus, 18 study subjects who had mortality out of which 82.3% had mortality specific to disease. 4 children had shunt related mortality. Most common shunt related complication associated with mortality was shunt blockage (n=2). Disease specific mortality was higher in age group of 6-12 years (p=0.003) while shunt related morality was higher in age group of 1-6 years (6.3%) due to high incidence of shunt related complication in this age group. In study conducted by Singh et al on doing survival analysis could not find any significant difference in survival in patients with respect to age group.[5]

In our study both disease specific and shunt related mortality was higher in children with tuberculous meningitis, which is attributed to higher disease specific mortality in pediatric hydrocephalus who had tuberculous meningitis. However, Singh et al found that patients with neoplastic etiologies were having poor survival when compared to benign and congenital etiologies.[5]

Type of VP shunt and outcome

In our study on correlating type of VP shunt inserted (low or medium pressure) with outcome, no significant association was observed. Incidence of shunt related complications as well as mortality was found be same

amongst both type of VP shunt. These findings were similar to those found in study conducted by Grover et al who reported that there is no significant difference in outcome with both type of shunt in pediatric hydrocephalus and degree of resolution of dilated ventricle is independent of shunt opening pressure.[17] Also, there was no difference in complication rates with either shunt type. Similar findings were reported by Pollack et al and Drake et al.[18,19]

Limitations

Limited sample size [n=52], may not be enough to extrapolate the results to a wider population. Maximum data was retrospectively collected, thus certain investigations like MRI, CSF study could not be collected in all the individuals. Because of limited numbers of follow up during study period, results of outcome cannot be extrapolated for long term outcomes.

CONCLUSION

In conclusion, our study demonstrates that pediatric hydrocephalus continues to pose significant clinical, surgical, and psychosocial challenges, with a predominance in females and children from lower socioeconomic backgrounds. Acquired hydrocephalus, particularly due to tuberculous meningitis, remains more prevalent than congenital forms, and Dandy-Walker malformation is the leading congenital cause. Clinical presentation and complications vary with age and etiology, with seizures, head enlargement, shunt blockage, and infections as common concerns. Despite surgical intervention, many children experience growth disturbances, school dropouts, and require multiple shunt revisions, especially those with tuberculous meningitis or Dandy-Walker malformation. Mortality is chiefly disease-specific, and malnutrition contributes to adverse outcomes. These findings underscore the necessity for early diagnosis, tailored management, and comprehensive follow-up to improve the quality of life and prognosis for affected children.

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