

Ventriculoperitoneal shunt infection rate and other associated complications of VP shunt insertion in Abuja, Nigeria

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ABSTRACT

Background: Complications associated with ventriculoperitoneal shunt insertion constitute a significant cause of morbidity and mortality among hydrocephalus patients. Despite this, VP shunt placement has remained the mainstay of treatment for hydrocephalus. The aim of this study is to evaluate the complications of VP shunt surgery in our environment and to identify the risk factors associated with it.

Methodology: Patients who had VP shunt surgery over a period of two years (Jan 2015–December 2016) were evaluated retrospectively by reviewing their hospital records. The patients' demography, aetiology and clinical presentation of the hydrocephalus, and complications were analysed using SPSS version 26.0. Results were presented in tables and figures.

Results: A total of 69 patients who had VP shunt over the study period had complete medical records available for review. Their age ranged between 2 days and 68 years with a male to female ratio of 1.8:1. Overall complication rate was 30.4%. Shunt malfunction (11.5%) and shunt infection (7.2%) were the commonest complications recorded. Late presentation was the most important risk factor for shunt complications.

Conclusion: The rate of shunt complications seen in this study compares fairly with studies in other parts of the world.

1. Introduction

Hydrocephalus can be defined as a disorder of cerebrospinal fluid formation, flow, or absorption leading to progressive distension of the ventricular system of the brain.^{1,2} Globally, the burden of hydrocephalus is high with prevalence rate of estimated to be between 0.9 and 1.2/1000 in the developed world.³ The rates vary significantly across populations, but hydrocephalus may account for about 32% of congenital neurosurgical conditions in Nigeria, 59% in Uganda, and 51% in the United Kingdom.^{1,2,4,5} In a systematic review by Dewan MC et al, the pooled estimated incidence of congenital hydrocephalus was highest in Africa and Latin America (145 and 316 per 100,000 births, respectively) and lowest in the United States/Canada (68 per 100,000 births).⁶

Ventriculoperitoneal shunt (VPS) remains the most common treatment for hydrocephalus globally even though it is associated with several short- and long-term complications that may need multiple

surgical interventions.⁷ Various shunt valve designs have been developed to improve the success rate of shunting for hydrocephalus. In developed countries, programmable shunt valves are widely used whereas in low-income countries like Nigeria, low cost, fixed pressure shunt valve system is widely used.⁸ The major disadvantage of VPS is the fact that it constitutes a foreign body and prone to complications like mechanical blockage, shunt infection, shunt migration, and rarely shunt protrusion.^{9,10} Among these complications, infection is one of the most serious, with variable incidence both in the literature and in clinical experience. Several studies have reported a higher incidence of complications in children in comparison to adults.^{2,11} However, this could be explained by a higher incidence of primary shunt insertions for children.

In this series, we aim to report the complications of ventriculoperitoneal shunt surgery in a tertiary neurosurgical center in north-central Nigeria. This information will help in preoperative counselling as well as resource management in a resource-poor locations within and outside

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2. Methods

This was a retrospective study conducted at the division of neurosurgery, National Hospital Abuja; a tertiary neurosurgical centre in north-central Nigeria. The study centre is one of three tertiary hospitals providing neurosurgical services to Abuja, Nigeria, a population of approximately 3.8million in 2023.¹² It includes a dedicated trauma centre and staff and services are provided 24 h a day, 365 days a year to adult and paediatric patients.

Consecutive records of 69 patients who had ventriculoperitoneal shunt surgery between January 2015 and Dec 2016 were retrieved and reviewed. All records were procedures performed by the same team. All patients had intravenous ceftriaxone 1 g at induction of anaesthesia. All ventriculoperitoneal shunts were prepared prior to insertion with approximately 30 ml of gentamicin in 0.9% saline solution at 1 mg/ml. Anti-microbial impregnated shunts were not used. All the patients in the study had an initial week two and week four follow up appointment after discharge. Data was collected from the patients' records using a structured proforma. The demographic data (age, gender), clinical presentation, aetiology of the hydrocephalus and complications were recorded.

The data was manually sorted and coded before entry into excel spread sheet. Statistical analysis was conducted using Statistical package for Social Sciences (SPSS) version 26.0. The results were presented in tables and figures. Frequencies and percentages were computed for categorical variables such as age, sex, presenting neurology and duration before presentation. The period before presentation was identified as time before symptom onset to presentation. Chi-square test was used to observe the relationship between different variable factors and surgical outcome. Any association having a probability value (p value) of <0.05 was considered statistically significant.

This study is retrospective review, therefore ethical approval was not required by the Ethics Committee of National Hospital Abuja.

3. Results

A total of 69 patients had VPS insertion during the study period. Of the 69 patients, 45 were males (65.2%) and 24 were females (34.8%) with a male to female ratio of 1.8:1. The age of distribution was uneven and ranged from two days to sixty-eight years and a median age of 6years. The most common presenting complaints were headache (33%) and progressive increase in head size (31.8%) (Table 1, Fig. 1). Duration of illness before presentation ranged from less than one week to greater than 52 weeks with a median of 29 weeks. The presenting complaints were most commonly headache (33%) and progressive increase in head size (31.8%), one sided body weakness (11.5%), visual/hearing loss (8.6%) and loss of consciousness (7.2%) (Table 1, Fig. 1). Duration of illness before presentation ranged from less than one week to greater than 52 weeks with a median of 29 weeks.

The most common indication for VP shunt insertion was congenital anomaly (congenital hydrocephalus, Chiari II malformation) accounting for 40.5% of cases. A fifth of patients, 14 (20%) suffered obstructive hydrocephalus. Eight (11.5%) of patients had VP shunt insertion following a Cerebrovascular accident (SAH, aneurysmal bleed, cerebellar hemorrhage, thalamic infarct). Thirteen patients (18.8%) had tumors resulting in obstruction, while two (3%) patients and three (4%) patients had ICSOL and meningitis (Table 1, Fig. 2).

All these patients had VP shunt inserted at some point in their care in addition to other surgical intervention. The majority of patients 60 (86.9%) had solely VP shunt insertion. Other surgical intervention in this series included tumor debulking surgery, insertion of external ventricular drains, biopsy and repair of myelomeningocele (Table 1).

Table 1
Clinical characteristics of patients.

Clinical Variable	Frequency	Percentage (%)
Age		
<1	29	42.0
1-16	22	31.8
17-39	6	8.6
40-60	7	10.1
>60	5	7.2
Sex		
Female	24	34.8
Male	45	65.2
Presenting Neurology		
Headache	23	33
Hydrocephalus	22	31.8
LOC	5	7.2
Visual/Hearing loss	6	8.6
Focal sided weakness	8	11.5
Duration Before Presentation(weeks)		
<1	16	23.1
1-52	36	52.2
>52	17	24.6
Diagnosis		
Congenital Anomalies	28	40.5
Obstructive hydrocephalus	14	20
CVA	8	11.5
Tumor	13	18.8
ICSOL	2	0.03
Post-meningitic hydrocephalus	3	0.04
Intervention		
VP shunt	62	89.9
VP shunt + Tumor excision	5	7.2
VP shunt + tumor biopsy	1	1.4
VP shunt + myelomeningocele repair	1	1.4
Complications		
Shunt Obstruction	8	11.6
Infection	5	7.2
Seizures	5	7.2
Others (Tumoural Haemorrhage, pericatheter leakage, hemiparesis, aspiration pneumonitis)	4	5.8

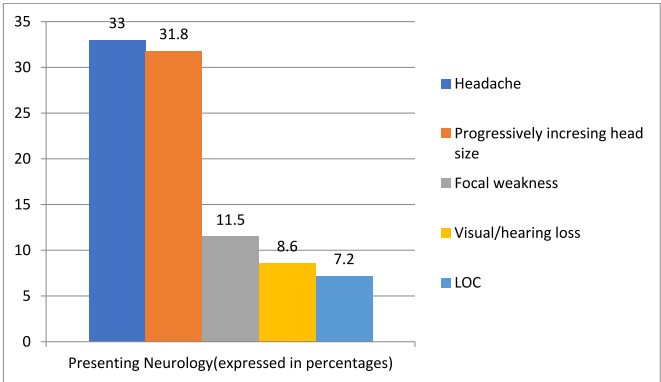


Fig. 1. Bar chart illustrating the clinical presentations in this series.

4. Discussion

Ventriculoperitoneal shunt insertion is the standard treatment for hydrocephalus. This technique was first developed by Kausch in 1908¹¹ and has reduced the morbidity and mortality from hydrocephalus. Infant mortality rate from hydrocephalus was reported to be as low as 3% and as high as 87%.^{7,13} These figures varied considerably by the presence/absence of concomitant congenital defects, treated/untreated status, follow-up duration, and WHO region.⁶

In our series, a total of 141 patients with hydrocephalus were treated in our facility in 4 years between January 2015 and December 2018 under review. This figure is undoubtedly disproportionate to the

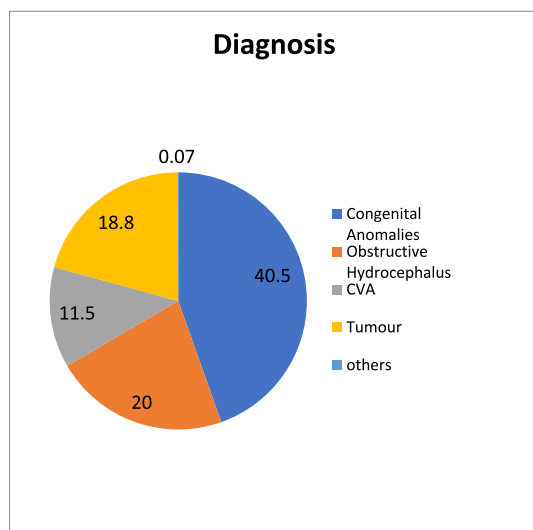


Fig. 2. Pie chart illustrating the diagnoses accounting for ventriculoperitoneal shunts in this series.

incidence of the disease in the surrounding community. This is likely higher due to incidence of nutritional deficiencies, low infant birth weight, greater incidence of perinatal and neonatal infections, and delayed antenatal diagnosis. In addition to this, a combination of medical and socioeconomic factors, including higher birth rates, poverty, traditional beliefs, poor awareness of the amenability of hydrocephalus to orthodox medicine, poor infrastructure, and limited access to neurosurgical treatment constitute a greater burden of care for management of hydrocephalus.^{8,10}

This series recorded a slight male preponderance in the incidence of hydrocephalus [Table 1] with a male to female ratio of 1.8:1 which is similar to the reports in other parts of Nigeria and America.^{6,8,14,15,16} There was no obvious reason for this finding. A study in Enugu, however reported a slight female preponderance of 1.3:1.¹⁷

Hydrocephalus is predominantly a disease of infants; hence, the disease was most commonly recorded in patients with age <12 months, 29 (42%). This is in keeping with findings in earlier studies.^{8,14,16} In this age group, the cranial sutures are yet to fuse at this early age and pressure created by accumulation of cerebrospinal fluid (CSF) in the ventricles causes a back-pressure effect on the cranium, widening the sutures, and expanding the head circumference (mega cranium); a feature pathognomonic of hydrocephalus in childhood.

In a review of multiple studies conducted over a forty-year period, a complication rate of 17–33% was recorded after VP shunt surgery. These complications occurred within the first year of VP shunt insertion.¹⁸ Our series report a complication rate of 30.4% (21 out of 69 patients). This is like a study that reported 28.1% and 34.4% complication rates in Kaduna and Ilorin respectively.^{8,19} However, lower complication rates have been reported locally with two studies in Benin City and Ile-Ife reporting rates of 20.9% and 25.8% respectively.^{16,17} In our series, the most common complication encountered was shunt obstruction (11.6%, 8 of 69 patients) and was followed by shunt infection rate of 7.2% (5 of 69 patients). Seizures were also recorded in 5 patients (23.8%). Other complications were peri-catheter leakage, aspiration pneumonitis, hemiparesis and tumoral hemorrhage which were found in one patient each.

Complete obstruction of CSF flow is the most common cause of shunt malfunction. It can occur at any point along the length of a CSF shunt from ventricular catheter to valve to distal catheter.²⁰ In the reports by Udoh and Gathura et al, a shunt obstruction rate of 11.8% and 11% were reported.^{16,21} These findings were similar to the rate of 11.6% in this series. It clinically presents as features consistent with acutely elevated intracranial pressure (ICP) leading to recurrent hospital admissions and

for revisions and replacements. Infants will generally present with difficulty feeding, nausea/vomiting, and irritability. Physical examination will disclose a bulging fontanel. Older children and adults usually present with headaches, cognitive difficulties, nausea/vomiting, and drowsiness/somnolence. Fundoscopic examination will disclose papilledema.^{20,21,22} Brain parenchyma and tissue debris such as blood and proteinaceous fluid have been hypothesized to explain clogging of shunt catheters. Pieces of choroid plexus have also been reported to occlude the shunt catheters.²⁰ In our series, patients presenting with these symptoms received an urgent CT brain scan and subsequent shunt revision surgeries.

The prevalence of infection (7.2%) recorded in this study falls within the variable rates of 2.2%–39% reported in earlier studies^{8,16,17,23,24} and tallies with the overall infection rate of 6.98% observed by Wu et al in China.¹⁸ It is however lower than 11.7% reported by Simon et al in a study of over 7000 children after shunt placement in America in 2010.²⁵ Two other studies from Enugu, reported similar findings, 6.6% and 8.6% in 1995 and 2013 respectively.^{23,26} Higher incidences of infection rates were however recorded in other parts of Nigeria where 19.4% and 21.7% infection rates were recorded in Ile-Ife and Benin City respectively. Predisposing factors to shunt infections include type of shunt implanted (antibiotic impregnated or not), patient's age at shunt insertion, perioperative antibiotics, operative room traffic, duration of the shunt placement operation, experience of the neurosurgeon, and cause of hydrocephalus.^{8,23} Enoch et al identified the experience of the surgeon and age of the patient as independent risk factors for shunt infection. Double gloving, prophylactic antibiotics, shunt impregnated with antibiotics (usually rifampicin or clindamycin) are reported to reduce shunt infections. The cost of antibiotic impregnated shunts limits its use in developing climes. Most commonly implicated organisms in shunt-associated infections are coagulase-negative Staphylococcus and *Staphylococcus aureus* and other skin bacteria followed by Gram-negative bacteria.^{2,8,23,26} Microbiology report was not reviewed in our series.

Presented results must be considered in the context of the limitations of this study. First, data regarding underlying risk factors for complications and the impact of the primary pathology were not evaluated in the study. Secondly, specific disease groups such as Normal Pressure Hydrocephalus (NPH) were not encountered in this series. Finally, being a retrospective study, the limited information on clinical records and the lack of randomization in the study design inevitably hinders extensive analysis and generalizability of the conclusions that can be drawn.

5. Conclusion

Our series have shown that about one of three persons undergoing ventriculoperitoneal shunt surgery will experience complications. While shunt infections affect 7.2% of our patients, shunt obstructions are the most common complications encountered. Because the study was retrospective, associated risk factors could not be determined and must be evaluated in future studies.

CRediT authorship contribution statement

Obinna M. Ayogu: Conceptualization, Data curation, Writing – review & editing. **Kenekukwu K. Igbokwe:** Conceptualization, Writing – original draft, Writing – review & editing. **Kassim M. Jabir:** Formal analysis, Writing – review & editing. **Efeomo D. Onobun:** Software. **Cyril I. Okpata:** Methodology. **Ugochukwu Ugwuanyi:** Supervision. **Ikechi Ekpandu:** Validation. **Edidiong A. Essiet:** Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviations

CSF: Cerebrospinal fluid
 ICP: Intracranial pressure
 ICSOL: Intracranial Space Occupying Lesion
 LOC: Loss of consciousness
 SAH: Subarachnoid Haemorrhage
 VP -: ventriculoperitoneal
 VPS -: Ventriculoperitoneal shunt
 WHO: World Health Organisation