Complications of Ventriculoperitoneal Shunt for Infantile Hydrocephalus: A Single Nigerian Centre Experience

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ABSTRACT

Background: Ventriculoperitoneal shunt (VP–shunt) is one of the easiest and most common ways of treating hydrocephalus worldwide. Common post-operative complications include shunt malfunction (obstruction, disconnection, fracture), infection of skin and hardware, exposed/extruded shunt, calcification and per anal extrusion. **Objectives:** A 5-year retrospective review of all complications observed among infants with VP Shunt in our centre. **Methods:** The study period was between July 2017 and June 2022. Extracted data included: Demographic data on the Age and sex at presentation, type of Hydrocephalus, and the observed complications. **Results:** Forty-six infants comprising 32 (70%) boys and 14(30%) girls had VP Shunt, with ages (number) of < 1 month (26.1%), 1 – 6 Months (43.5%), and 7 – 12 Months (30.4%). Types of Hydrocephalus were congenital (A. S. in 13, NTD associated in 18) and acquired (post meningitis in 13, IVHP in 2). Complications were observed in eight (17.4%), consisting of 6(75%) Males and 2(25%) Females, with M: F of 3:1. Complications among the eight (8) patients include: Shunt Obstruction (50.0 %), Shunt Disconnection (12.5 %), Shunt Infection (50.0 %), Skin Infection (25.0 %), Shunt calcification (12.5 %), Exposed Shunt(12.5 %), Extruded Shunt (12.5%), Per anal protrusion (12.5 %) and Death (25.0 %). **Conclusions:** Outcomes were very good, with few manageable complications.

Keywords: Children, Complications, Hydrocephalus, Infants, VP – Shunt.

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Introduction

Hydrocephalus (HCP) is clinically defined as the excessive and abnormal accumulation of cerebrospinal fluid (CSF) in the intracranial cavity; radiologically, it is defined as the dilatation of the ventricles or the increase in diameter of both temporal horns of the lateral ventricle to 62 mm. Patho-anatomically, it is defined as the extension of the frontal horn of the lateral ventricle beyond the genu of the corpus callosum[1]. However, the basic definition is an abnormal accumulation of cerebrospinal fluid within the brain's ventricles.[2]

Its reported incidence ranges from 0.2 to 3.5/ 1000 births.[3] HCP is either due to subnormal CSF reabsorption (non-communicating or communicating) or, rarely, CSF overproduction.[4] Clinically, it may be classified as communicating or non-communicating. A variety of congenital and acquired conditions may cause both types.[5] Hydrocephalus ultimately raises intracranial pressure, with or without ventricular dilatation.[6]

It is one of the most common reasons for neurosurgical consultations, irrespective of the patient's age.[7, 8] Over

30,000 procedures are performed annually in the United States.[9]

Ventriculoperitoneal Shunt surgery was first reported in 1898 and has become the mainstay of treatment for Hydrocephalus.[10] Most neurosurgeons prefer this because of fewer complications and the relative ease of performing it.[11]

Notwithstanding, this procedure remains one of the most complication-prone, with failure rates of 30% to 40% within the first year after implantation and 50% within two years of implantation.[12, 13] Some had reported incidences of VP-shunt failure/complications ranging from 25% to 40% at one year and 63% to 70% at ten years.[14] Most first-shunt complication revisions are done within the first year after the primary shunting.[15]

Obstruction is the most common cause of shunt malfunction/failure, with the proximal ventricular catheter (the most common site), valve mechanism, and distal peritoneal catheter in this order, as reported.[16] Disconnection at a junction or break at any point, an infection may produce obstruction and hardware erosion through the skin. Other complications include peritonitis from shunt infection, hydrocele, CSF ascites, and catheter tip migration.[16]

The incidence of infection of VP-shunts was approximately 8–10% in large trials.[17] Some wider ranges were reported from 4% to 30% of cases, varying according to patient history, presence of external drainage, and history of recent infection. The latency between surgery and presentation for infection ranges from 15 days to 12 months (infancy).[18,19] Raygor [20] *et al.* reported that most infections occurred within two months of surgery. Young age (< 6 months) at the time of surgery and the presence of a postoperative CSF leak were significantly associated with postoperative shunt infection.[20]

Although shunt exposure is a risk factor for shunt infection, it could occur the other way around. An existing infection around the shunt material may give way to shunt exposure. Continuous stress on the skin, especially where the skin is thinner and more fragile, may eventually lead to shunt exposure.[21, 22] This is attributed to the thinner skin of the child's head, increasing its risk of protrusion. The scalp becomes more delicate in children with Hydrocephalus, so VPS exposure becomes more likely.[23]

Shunts may disconnect, fracture, or migrate. The risk of disconnection may be mitigated by securing the shunt system tightly with a non-absorbable suture and limiting the number of connections when possible. Placement of the valve and connections over the skull, where these connections are not subjected to repetitive movement at the neck, is also encouraged.[24]

Anal protrusion of the peritoneal catheter has been reported as a complication with Chhabra shunts, probably because it has a slight tendency to stick and erode the bowel when it is in a dry state [25] and this could be a factor responsible for shunt migration in this type of shunt.

It is known that over-drainage of CSF in a child with a small abdomen may cause Cerebrospinal Fluid ascites. This increases the intraperitoneal pressure and may cause an inguinal hernia or hydrocele to develop.[26]

We retrospectively reviewed all infants with VP-shunt for Hydrocephalus and the complications observed in our Centre.

Methods

We undertook a five (5) year retrospective review of all infants (less than a year old) that had ventriculoperitoneal shunt (VP Shunt) as a treatment for hydrocephalus and the complications that ensued. The study was conducted from July 2017 to June 2022. Our Hospital, the Federal Medical Centre, is a tertiary medical centre in Yola, Adamawa state, in north-eastern Nigeria. We routinely use a medium-pressure Chhabra shunt and "bath" it in 160 – 240 mg of Gentamycin in 20 ml of normal saline, followed by intra and postoperative parenteral antibiotic (Ceftriaxone) for five days.

All infants who had VP Shunt in our hospital were included; excluded were those who had it performed elsewhere but were followed up in our institution because of proximity to their home. The patients were followed up clinically for the first seven days as an inpatient and in the outpatient clinic postoperatively upon discharge at one month, three months, extended to 6 months, then annually.

Extracted data on the patient's Demography, type of Hydrocephalus, available diagnostic imaging modality, and the observed complications with their period from the patient's case notes were analysed. The demographic data included the age at presentation and sex of the patient. Data were analysed using Statistical Package for Social Sciences (SPSS) version 26.0 (Chicago, IL, USA). Analysis was carried out using descriptive statistics and illustrated as proportions and percentages.

Results

A total of 80 patients had VP-shunt during the study period. There were 46(57.5%) infants, 30 (37.5%) older children, and 4(5%) adults. The infants comprised 32 (70%) boys and 14 (30%) girls. The infant's ages at presentation before surgery are as in Table 1.

The various types of Hydrocephalus were congenital (Aqueduct of Sylvius stenosis in 13, Neural Tube Defect associated in 18) and acquired (post meningitis in 13, Intraventricular Haemorrhage of prematurity in 2), as shown in Figure 1.

Infants with Neural Tube Defect-associated Hydrocephalus were 18: This includes 14 (77.8% of 18) that presented in pre–excision period (with 12 associated with Myelomeningocoele and 2 with Encephalocoele) and four that developed Hydrocephalus in the Post – excision period (with 3 Myelomeningocoele and 1 Encephalocoele)

Various complications of V-P Shunt were observed in only eight (17.4%) infants, in 6(75%) Males and 2(25%) Females, with a male-to-female ratio of 3:1.

Complications were diagnosed based on clinical suspicion, aided by readily available imaging modalities. The imaging modalities at the onset of the complications are presented in Table 2.

The various complications observed were predominantly shunt obstruction and shunt infection. However, the total number of patients with complications was few. The ages at complication, period, and number are shown below in Table 3.

Some of the postoperative complications observed are shown below in Figure 2.

Table 1: Showing the patient's age ranges at presentation(pre-operative).

Ages at presentation	Number	Percentage
< 1 month (Neonate)	12	26.1%
1 – 6 Months	20	43.5%
7 – 12 Months	14	30.4%
Total	**46**	**100%**

Table 2: Showing the available diagnostic imaging modalities

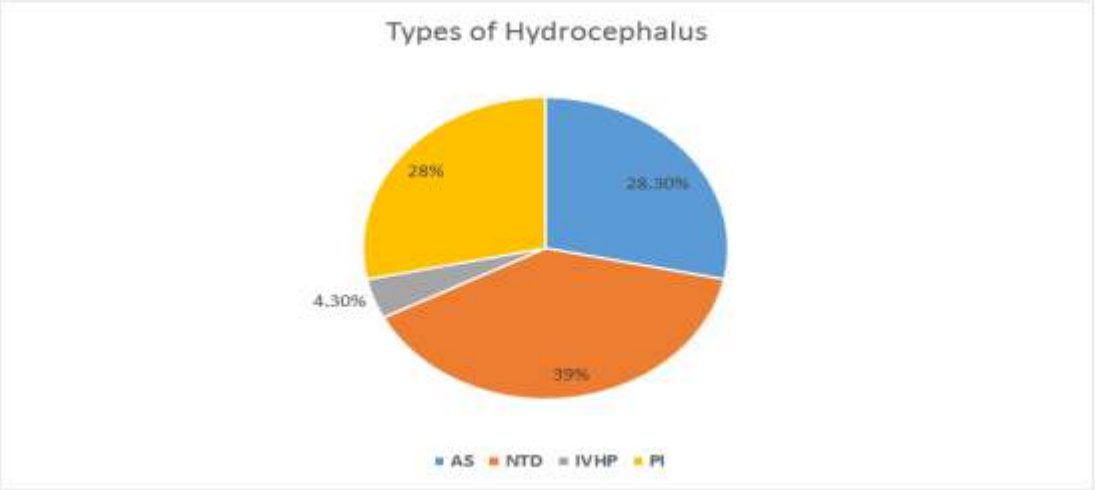
Imaging at complications	Number	Percentage
Trans fontanelle Ultrasound Scan	08	100%
Plain radiograph (shunt series)	06	75.0%
Computed Tomography Scan	02	25.0%
Magnetic Resonant Imaging	01	12.5%

Table 3: showing complications, age at complications, Postoperative period at complication and number.

Type of complications	Age	Post-op Period	Number	Percentage
Shunt Obstruction	3 months	2 months	4	50.0 %
Shunt Disconnection	11 months	8 months	1	12.5 %
Shunt Infection	3 months	1 month	4	50.0 %
Skin Infection	3 months	½ month	2	25.0 %
Shunt calcification	4 months	4 months	1	12.5 %
Exposed Shunt	4 months	3 months	1	12.5 %
Extruded Shunt	3 months	1½ months	1	12.5%
Per anal protrusion	4 months	3 months	1	12.5 %
Death	3 months	2 ½month	2	25.0 %

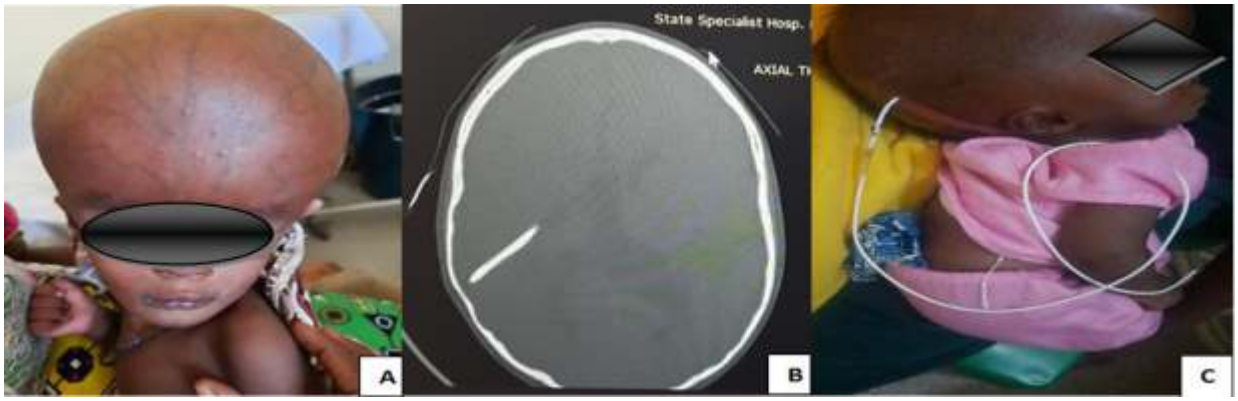
NB: Some patients had multiple complications.

Figure 1: Showing various types of Hydrocephalus at presentations.



AS = Aqueductal Stenosis, NTD = Neural Tube Defect, IVHP = Intraventricular Haemorrhage of Prematurity, PI = Post Infective.

Figure 2: Showing some of the complications.



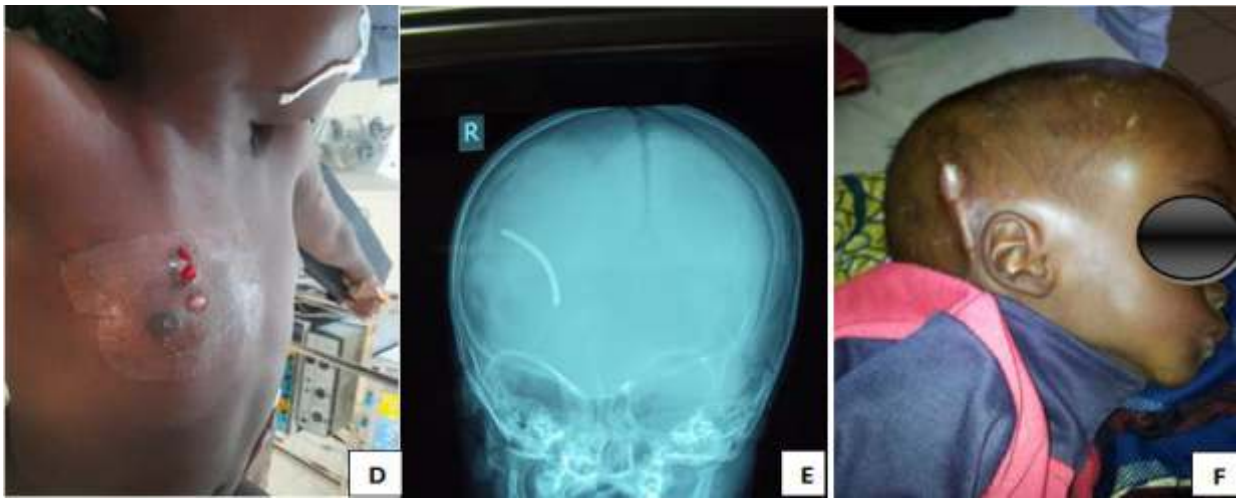


Figure 2 above shows a typical craniofacial disproportion in an infant with Hydrocephalus(A), an axial computed tomography (bone window) showing a calcified intraventricular catheter (B), an infant with a near total extrusion of a Ventriculoperitoneal shunt (C), a nodular discharging sinus along a shunt tract indicating an infection (D), a plain Anterior – Posterior skull X-ray showing total intracranial migration of a disconnected ventricular catheter (E), an infant with an exposed shunt (F).

Discussion

Preoperatively we found that infantile Hydrocephalus is characteristically commoner among boys. Kestle[17] reported slight male preponderance, and likewise, Mwang'ombe[27] in Nairobi found male preponderances but in lesser proportions than ours. However, Babagana *et al*.[28] found a similar distribution of boys (65%) to ours in the same institution but from a different study in 2020.

Among the infants, the main affectation involved 1 – 6 months olds, which is similar to the findings by Babagana *et al*. [28] that found 80% of Hydrocephalus among infants.

About 17.4% of our patients were found to have developed various complications, with some in multiples. Emejelu[29] reported higher complications of 28.1%, while lesser complications were reported by Amacher[30] (13%) and kestle[31] (8 – 10%), respectively.

We found the complications highest among the infants compared to the other age groups. It is similar to the findings of Hamdan[22], with up to 73% of complications among infants.

Our diagnoses of the complications were primarily based on clinical grounds, confirmed by imaging modalities of Trans Fontanelle Ultrasound Scan (TFUSS) in all infants, Computed Tomography of the brain (CT Brain) in some, and rarely by Magnetic Resonance Imaging (MRI). Gathura[32] reported the availability of very few CT scans among his patients. Radionuclide study is not available in our Centre.

We found obstruction (50%) and infective (50%) complications to be the commonest, with most observed within ½ a month to 4 months of the initial surgery and found mainly among those under six months old infants. Gathura[17] equally found mechanical complications of obstructions similar to ours (51.1%) but with lesser infectious (32.7%) complications in this order to be common among infants. While Usman *et al*.[33] found infections higher than obstruction in another study in 2020 among children in the same institution.

With regards to the number of obstructions, three (3, 75%) were proximal (ventricular catheter), and 1(25%) was distal (peritoneal catheter) obstructions. All four obstructions were associated with shunt hardware infection. Additionally, 2 of them began as skin infections. Dickerman[34] and McGirt[35] *et al*. found the common site of the block to be the proximal catheter (intraventricular).

We observed that infections appeared earlier than obstruction. Binitie[36] found this may occur within weeks, months, or even years after shunt placement. Infections tend to cause early shunt failures, while

catheter occlusion/obstructions typically account for late shunt failures.[37]

The complications and the ultimate need for shunt revisions were commoner among those less than 6 months old. Tervonen[38] found that patients younger than six months old were at higher risk for shunt revision from mechanical issues.

Our finding of 12.5% shunt tract infection is higher than the finding of Usman et al. of 3.3%, though the latter were essentially surgical sites and not a tract. We found the tract infection characterised by nodular-like lesions and some areas resembling sinuses. This finding of multiple skin ulcers and draining sinuses (Suppurative nodules and sinuses) has been reported elsewhere.[39,40]

We found a calcified intraventricular component of the shunt. Shunt calcification is a rare condition, mostly reported among adults. Ours was found in an 8-month-old child. Kural *et al.* [41] have seen this in a 10-year-old patient. Intraventricular catheter calcifications are rare, and the most extensive calcification was found in the neck, where the catheters were subject to heavy mechanical stress.[42]

We found a case of an anal protrusion (1, 12.5%) of the peritoneal catheter at the age of five (5) months. Ezzat [43] found as many as 4 (66.6%) between the ages 3 – 7 months with a mode of 6 months.

Of clinical importance, we observed that the patient with anal protrusion had a preceding history of low-grade fever and passage of loose stool (mimicking diarrhoea). This is contrary to what Ezzat[43] found in Cairo, with Vomiting and bulging of the fontanelle dominating.[43] In our index case, the shunt valve was still functional despite the exposure.

Another patient (1, 12.5%) had near total shunt extrusion following the scalp tract's ulceration. Earlier reports were those of its extrusion through the abdominal wall, Chest wall, and neck incision, respectively.[44, 45, 46, 47] There was a reported case of extrusion from the scalp behind the ear by Ghritlaharey[48] following the disconnection of a shunt. However, this was at a lower position (neck).

Our outcomes of ventriculoperitoneal shunt surgeries were good (82.3%). During a one-year follow–up period, the overall mortality was 4.4% among our patients. This is far better than the overall good of 40.2%, poor outcomes in 59.8%, and mortality of 7.1% by Gathura[32] from a sub–Saharan study.

Disclosure:

The authors report no conflict of interest concerning the materials or methods used in this study, including the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Acquisition of data, review of the final version of the manuscript and its approval for submission were by all authors.

Conclusions: Ventriculoperitoneal shunt is the commonly accessible treatment modality for Hydrocephalus in our setting. We have routinely carried out VP Shunt on children, mainly infants. We found few manageable complications in young children (infants), multiple in some with overall good outcomes.

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