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Outcome of Ventriculoperitoneal Shunt insertion at Myungsung Christian Medical Centre in Ethiopia

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Background: ***We investigated the feasibility of shunt insertion procedures with acceptable short-term outcomes in Ethiopia, and to identify factors associated with good and bad outcomes.***
Methods: ***This is a hospital based prospective cohort study of outcome of ventriculoperitoneal shunt insertion at Myungsung Christian Medical center (MCM), Addis Ababa, Ethiopia in the period between January 2011 and December 2012. Medical records were reviewed in a structured questionnaire prepared for this purpose. Epidemiological data, head circumference, clinical investigations, etiology of the hydrocephalus, details of the ventriculoperitoneal(VP) shunt insertion, outcome by the end of 6 months, morbidity and mortality data were collected. Outcomes were graded as good, fair, or poor, according to head circumference, anterior fontanels status, visual, motor, and seizure criteria. Difference in proportions was examined using Chi-square test.***
Results: ***The Authors review141 VP shunt insertions in 114 patients≤ 12 years of ageatMCM, 61(53.5%) were male and 46(46.5%) female. The median age was 3 months (range 0.3-144); the mean head circumference at presentation was 50.4 ± 10.1cm (range, 34-106). The commonest causes of hydrocephalus were spina bifida (42.3%) and post infectious (20.2%). Early complications following surgery were seen in 65(58.0%) patients. The commonest complication was mechanical failure in 54(48.2%) patients, under shunting constituted 83.3% of the mechanical shunt failure, shunt infection being 7%. Follow-up was available in 75.4% of children, with a mean follow-up period of 6.8 ± 7.2 months (range 1-36). In-hospital mortality was 1.8%. The overall shunt function rate at last visit was 88.3%, head circumference ≥ 50 cm had significant early complication compared to those with ≤ 50 cm. Age and Sex were not significantly correlated to the occurrence of complications and outcomes.***
Conclusion: ***Spina bifida was main etiological cause of hydrocephalus. Our study has documented good outcomes at 12 months follow-up period for VP shunt insertion with acceptable early complication rates. However, children with a head circumference greater than 50 cm had significant early complication (p=0.028). Given the availability of fully subsidized VP shunts in a country with enormous number of hydrocephalic children, shunts will continue to play a pivotal role in the management of hydrocephalus in Ethiopia.***

Key words: Ethiopia, hydrocephalus, outcome, Ventriculoperitoneal shunt

Introduction

The prevalence and incidence of hydrocephalus in developed nations is estimated as 0.9-1.2/1000 and 0.2-0.6/1000 respectively.[1]No reliable estimate is available in the African literature, but its incidence is likely higher because of untreated / poorly treated neonatal meningitis, congenital malformation and nutritional deficiencies. Some of several hypothesized causes of pediatric hydrocephalus include, congenital malformations, meningitis/ventricuitis, tumors, traumatic head injury or subarachnoid hemorrhage[2,3]. Two forms of hydrocephalus exist, communicating and non-communicating. The clinical exam is the most readily available

investigation for the diagnosis of hydrocephalus. Hydrocephalus and its complications such as shunt malfunction or infection are also regularly diagnosed by cranial imaging including ultrasonography, computed tomography (CT) or magnetic resonance imaging (MRI). The surgical treatments for hydrocephalus are inserting a shunt system to redirect the flow of cerebrospinal fluid (CSF) to other parts of the body or endoscopically diverting CSF from ventricular system to subarachnoid space. Despite the increasing use of endoscopic procedures in our centers, Ventriculoperitoneal (VP) shunt placement remains the principal method of treating hydrocephalus in Ethiopia. It is the gold standard against which newer procedures are judged. VP shunts are associated with substantial complication rates. Worldwide failure rates currently still range between 25% and 40% within the 1st year following insertion[3-6].

This was a prospective cohort study of patients who had undergone VP shunt surgeries with respect to etiology, complications and outcome.

Materials and Methods

This is a prospective study of 114 patients≤ 12 years with hydrocephalus who received VP shunt as primary treatment (93%) or VP shunt insertion following endoscopic third ventriculostomy (ETV) failure between January 2011 and December 2012 at Myungsung Christian Medical Center (MCM). Medical records were reviewed meticulously in a structured questionnaire prepared for this purpose. Epidemiological data, duration of symptoms, clinical investigations, etiology of the hydrocephalus, details of the VP shunt insertion, complications and outcome by the end of 6 months, and morbidity and mortality data were collected.

All the shunts used were medium pressure shunts. Shunt complications were looked for during the follow up period, even though it was not always feasibledue to high dropout rate. Complications were generally put as Infectious, mechanical failure and seizure. Mechanical shunt failure can occur through proximal obstruction, distal obstruction, component separation/fracture/migration or excessive CSF drainage A ventricular tap was routinely carried out for majority of patients with infected/ ruptured spinal bifida andif infection is strongly suspected, CSF analysis was done, Gram stain test and cultures/ sensitivity were also obtained for those patients who presented with a elevated CSFwhite blood cell(WBC)count and protein values.

The category post-infectious hydrocephalus(PIH)was used in cases in which one of the following criteria were met: 1) There was a clear history of meningitis, which was followed by onset of the hydrocephalus. 2) There was a history of a febrile illness, followed in closely by the onset of hydrocephalus. 3) Ultrasonography and CT scans demonstrated loculation/septations/ bands in the ventricles. Some of them were labeled as PIH after ETV. Non post-infectious (NPIH) included cases of congenital hydrocephalus due to aqueductal stenosis, Dandy-Walker malformation and other congenital malformations, and hydrocephalus associated with tumors. The Chhabra medium pressure “slit-valve” shunt donated by International Federation of Spina Bifida was used in the majority and Hakim-Codman and Integra in few cases prophylactic intravenous ceftriaxone was given preoperatively.

Complications were classified as early: complications occurring between immediate postoperative period and discharge, Late: Complications in the follow-up period. Outcomes were graded as good, fair, or poor, according to visual, head circumference, and anterior fontanelle status, motor, and seizure criteria. Mortality was defined as death from any cause before discharge or within 30 days of the operation. Data was analyzed using computer-based software IBM SPSS statistical data editor version 20.0. Independent-samples T test for

dichotomized variables and one-way ANOVA for multiple comparisons were used. A p- value of < 0.05 was considered significant and ethical clearance was obtained from MCM.

Results

One hundred thirty-five patients were treated with VP shunt insertion our center. One hundred-fourteen patients ≤ 12 years of age treated with VP shunt insertion were included in the current study, of which 61(53.5%)were male and 46(46.5%) female. A slight male predominance was observed, in a male: female ratio, 1.2:1, and statistically insignificant (p=0.38). The median age of patients was 3.0 months and ranged from 1 day to 12 years, majority of the patients were below 1 year (71.1%) and 83% were below 4 years of age, mean age at shunt insertion being 10.1±18.3 months with range, 0.3-144 months (Table 1). The mean head circumference at presentation was 50.4 ± 10.1cm (90th percentile) with a range, 34-106 cm. All patients had a radiologic investigation available before treatment, computed tomography scan results were available for 59(51.8.%) patients, brain MRI was used in 9(7.9%) patients and brain ultrasound was method of investigative modality in 36(31.6%)patients (infants with open fontanelle). The mean time delay from admission to the first VP shunt insertion was 4 ± 5.06 days (range 1-20).

Table 1. Socio-demographic Characteristics of Patients with Hydrocephalus in MCM, Addis Ababa: 2011 – 2012.

Age (months)	Male (%)	Female (%)	Total (%)
<3.0	28(20.7)	30(22.2)	58(43.0)
>3-6	8(5.9)	6(4.4)	14(10.4)
>6-12	15(11.1)	9(6.6)	24(17.8)
>12-24	3(2.2)	1(0.7)	4(2.9)
>24-48	3(2.2)	5(3.7)	8(5.9)
>48-96	2(1.5)	2(1.5)	4(2.9)
96+	1(0.7)	0(0.0)	1(0.7)
Total	61(54.1)	53(45.9)	114(100.0)
Mean=10.12±18.3(range, 0.3-144 months Median=3.0 months			

Table 2. Percentage of the Various Causes of Patients with Hydrocephalus in MCM, Addis Ababa: 2011 – 2012.

Age (mos)	SB	CMII	DWM	PIH	CAS	Masses	Total
≤3.0	31(27.2)	12(10.5)	3(2.6)	8(7.0)	2(1.8)	1(0.7)	58(50.9)
3.1-6.0	8(7.0)	0(0.0)	0(0.0)	3(2.6)	2(1.8)	1(0.7)	14(12.3)
6.1-9.0	5(4.4)	0(0.0)	0(0.0)	3(2.6)	2(1.8)	5(4.4)	15(13.1)
9.1-12.0	2(1.8)	0(0.0)	0(0.0)	5(4.4)	2(1.8)	0(0.0)	9(7.9)
12+	3(2.6)	1(0.7)	5(4.4)	4	2(1.8)	3(2.6)	18(15.8)
Total	49(42.9)	14(12.3)	8(7.0)	23(20.2)	10(8.8	10(8.8)	114(100.0)

SB - Spina Bifida, CMII - Chiari Malformation type 2, DWM- Dandy Walker Malformation, PIH - post-infectious hydrocephalus, CAS - Congenital aqueductal stenosis.

Table 3. Distribution of early and late complications among the various age groups of Hydrocephalicpatients treated with VP shunt insertion in MCM, Addis Ababa: 2011 – 2012

Complications	Age Group (%)			
Early=114	0-6 mos	6-12 mos	12+ mos	Total (%)
Cardiorespiratory arrests	2(1.8.)	1(0.9)	0(0.0)	3(2.6)
Aspiration pneumonia	1(0.9)	1(0.9)	0(0.0)	2(1.8)
Death	2(1.8)	0(0.0)	0(0.0)	2(1.8)
Total	5(4.4)	2(0.7)	0(0.0)	7(6.1)
Late, n=112				
None	30(26.8)	12(10.5)	7(6.2)	49(43.8)
Undershunting	30(26.8)	6(5.4)	9(8.0)	45(40.2)
Infection	3(2.8)	4(3.8)	1(0.9)	8(5.2)
Overhunting	4(3.8)	0(0.0)	0(0.0)	4(3.8)
Seizure	1(0.7)	1(0.9)	1(0.9)	3(2.8)
Distal catheter problem	1(0.9)	1(0.9)	0(0.0)	2(1.8)
Skin break down	1(0.9)	0(0.0)	0(0.0)	1(0.9)
Extrusion via anus	1(0.9)	0(0.0)	0(0.0)	1(0.9)
Lost vent catheter	1(0.9)	0(0.0)	0(0.0)	1(0.9)
Total	72(54.0)	24(20)	18(25.9)	114(100.0)

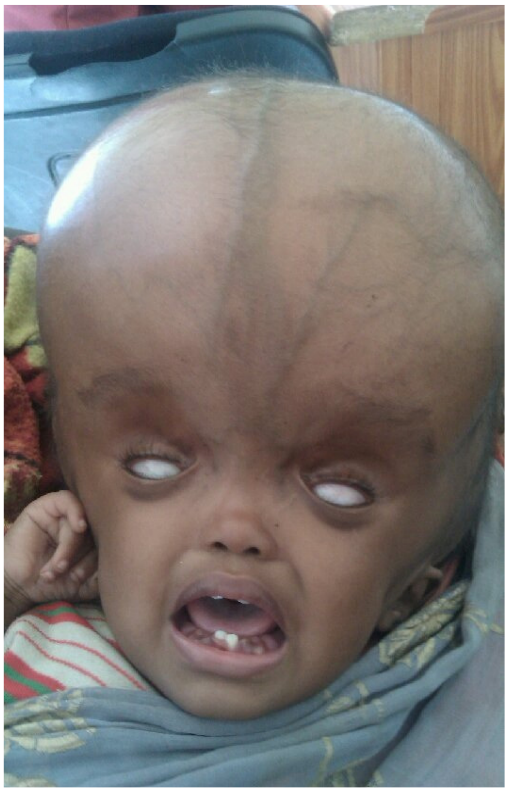

Figure 1. Typical patient in this series with severe Macrocephaly (HC, 63cm) and sunsetting of the eyes.

Table 4. Condition on discharge and outcome at 6 months of Hydrocephalus Patients treated with VP shunt insertion, Addis Ababa: 2011 – 2012

Condition	Frequency	Percentage
Improved	101	88.6
Same	9	7.9
Deteriorated	2	1.8
Death	2	1.8
Total	114	100.0
Outcome		
Good	53	46.5
Fair	6	5.3
Poor	1	0.9
Total	60	52.6

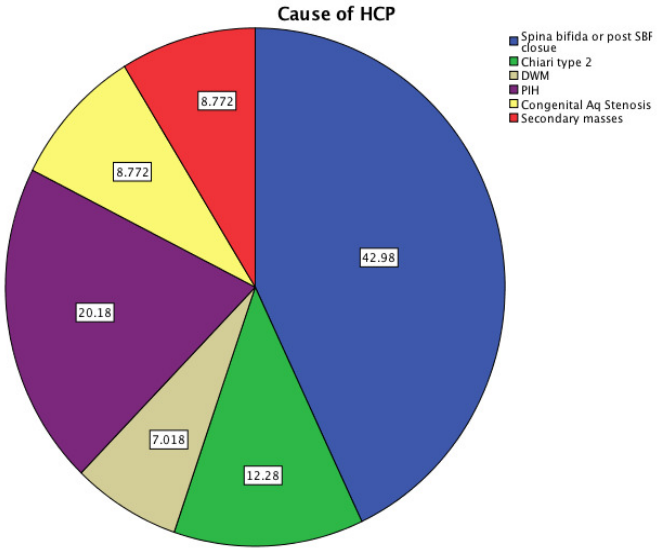

Figure 2. Pie chart showing the Various Aetiologies in 114 Patients with Hydrocephalus. SB=spina bifida, DWM= dandy walker malformation.

The causes of hydrocephalus identified in 114 patients include spina bifida, Chiari and Dandy walker malformation, and post infectious, congenital aqueductal stenosis, brain tumors. Spina bifida was significant cause of hydrocephalus in 42.3% patients (p=0.001) followed by post infection and Chiari malformation II in 20.2% and 12.3 %respectively (figure 1 and Table 2). Communicating type of hydrocephalus was seen in 34 patients (29.8%) and 80patients (70.2%) had non-communicating type of hydrocephalus

The ventricular insertion site was frontal in 70 patients (61.4%), parietal in 9 patients (7.9%) and occipital in 35 patients (30.7%). Three types of shunts were used Chhabra, Codman and Integra. Most patient 107(93.9%) received Chhabra shunts. In 114 patients with hydrocephalus, 141 VP shunt insertion procedures were done, 93(81.6%) were primary VP shunt insertions, 17 (14.9%) were revised once, 3 (3.5%) twice; and one patient had four revisions.

The surgery for VP shunt insertion went smoothly for 105 patients (92.1%). Four intraoperative complications were noted, such as bleeding and cardiorespiratory arrest and early postoperative complications including death were recorded in 5(4.4%) patients (Table 3). Early complications following surgery were seen in 65(57.0%) patients. The commonest complication was mechanical failure in 54(48.2%) patients, under shunting constituted 83.3% (45/54) of the mechanical shunt failure and 40% of the overall complications, 38/65 (58.5%) and 30/65(46.2%) of the under shunting occurred in the age group 0-6 months. Rare complications like extrusion via anus and lost ventricular catheter were seen in one patient each (figure 2). Shunt infection was demonstrated in only 7 patients (6.1%). The in-hospital mortality was recorded in 2(1.8%) patients. On discharge, 97/112 patients (86.6%) improved clinically and 9 patients (8.9%) were in the same condition, 2(1.8%) deteriorated.

All patients had 100% follow-up on their first visit within the first one-month after discharge, 89/112 patients (79.5%) had follow-up for the first 3 months, 87/112(53.4%) for 6 months, mean duration of follow-up was 6.8 ± 7.2(range 1-36 months). The follow-up rate at one year was 17.5%.

The shunt function rate at 6 months was good in 53/60 (88.3%) patients, because these patients had normal vision, motor activity, and decrement in head circumference, soft fontanelle and no seizures. Patients with a head circumference greater than 50 cm had significant early complication compared to those with ≤ 50 cm after VP shunt insertion (p=0.028).No significant age difference was noted between patients with complication and without complication (p=0.7);age was not also significantly correlated to the early outcome (p=0.76).Sex was insignificantly correlated to the occurrence of complications (p=0.32) and so was outcome (P=0.22).

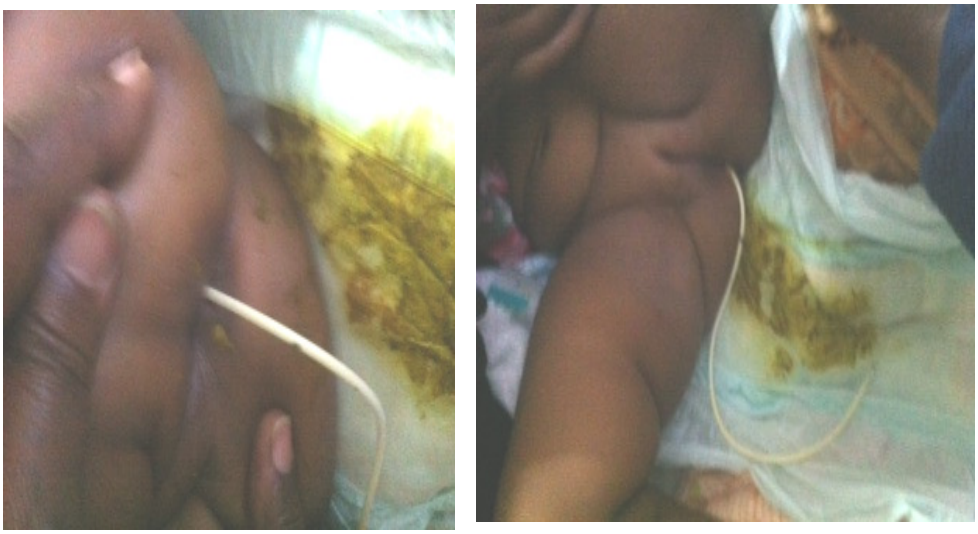

Figure 3. Extrusion of Peritoneal Catheter through Anus in 1-year-old Female Patient

Discussion

The mean and median age of patients at shunt insertion was 10.1±18.3 (range 0.3-144 months) and 3.0 months respectively,71.1% of the patients were below 1 year and 83% were below 4 years of age, this agrees well with Warf (2005), and Gathura et. al (2010) who reported mean

age of 13.3 months, 88% 1 year or younger and median age 3.3 months,84.6% of the children were younger than 1 year old repectively[2,3,7].

Fifty-four percent of the patients were male in our study, which is consistent with a previously reported male preponderance in hydrocephalus[3,8,9.] Gathura et. al, reported that female patients are more likely to develop infectious complications, but our results showed no significant relationship between sex and complications. This relationship has not been previously documented as well[9-11].

Imaging modalities such as CT and MRI are done in 65.1%, which makes accurate diagnosis possible and better compared to studies conducted in East Africa[2,3]. This might have contributed to a lesser mortality rate as compared to these studies. But cranial ultrasonography (US) is also an essential diagnostic tool in developing countries; it can readily assess ventricular size and it is relatively inexpensive[2].

The causes of hydrocephalus in the developed countries are intraventricular hemorrhage and congenital hydrocephalus. Most studies in developing countries report infection as a cause of hydrocephalus[2, 12]. In this study most cases are associated with spina bifida (49.7%) similar to a study done in Kenya [3]. This finding is strongly associated with rampant malnutrition in women of childbearing age. These women are also prone in developing folate deficiency, which is highly associated with increased occurrence of neural tube defects.

The most common surgical intervention to treat hydrocephalus is the insertion of a VP shunt and yet, VP shunts are associated with a high rate of complications all over the world, with failure rates reaching up to 40% within the 1st year of insertion. In this study, the over all early complication rate was 57.0% and is higher than the rate reported in studies done from Africa, Malaysia, Canada and Europe[3-7, 13,17-22.] High complication rate compared to not only Western literature but also Sub-Saharan Africa could be explained as follows, our patients present with severe malnutrition, advanced disease, poor skin integrity. Delay in surgical intervention, and generally physical debilitation is also routinely seen in our patients[2, 3,7]. The infection rate was 7% and is comparable to the rate in the developed nations, which is reported to be 2 - 9%. [3,11,14]Young age has previously been identified as a major risk factor for shunt infection, and our infection rate of 7% is in line with published results for infants.[15, 16,24] An overall infection rate of 5 to 10% without regard to risk factors is considered acceptable, and commonly reported in the literature[15].

At MCM, common techniques to avoid shunt infection include the use of generous skin preparation, meticulous and consistent surgical technique, improving intraoperative factors like double gloving, Ioban dressing of the operative site, flushing the shunt with gentamycin and the avoidance of shunt-to-skin contact and preoperative prophylactic antibiotics[2, 3,16,23,25]

The other important complication is mechanical failure seen in 47.4%, higher than a multicenter study from Canada which reported 40% mechanical failure[17] and most reports[2,3.] In general high rate of mechanical failure could be due to the limited experience of the surgeon doing the procedure and the number of shunt procedures done at the center.[16] Hence, considering these complications endoscopic third ventriculostomy presents a plausible option in the management of hydrocephalus[2].

The overall surgical mortality rate in this study is 1.8%, it is lower than reported in Sub-Saharan studies such as Kenya (6%)[3] and Uganda (5.3%). [2,7] Although the true figure was probably

higher considering the likelihood of death in patients lost to follow-up.[3]Eventhough, survival and long-term mortality rates are not included in this review because extremely low one-year follow-up rate (17.5%), our results would have been not far from reports documented in most African counties. A recent study from Zimbabwe revealed a medium-term survival (over 2 years) of only 33%–47% of patients[18], and one-year mortality rate of 16% by Warf [7]. Unlike to the report by Gathura et al[3]. Age and sex were not significantly correlated to the occurrence of early complication, less complications rates were observed in patients with head circumference ≤ 50 cm compared to > 50 cm., this is in agreement with study conducted in East Africa [2,3].

Shunt function rate of 88.3% at mean follow-up period of 6.8 months is higher than reported by Gathura et al[3] and others who reported shunt function rate of 65% at 2 years. It is too early to compare ours to most studies with relatively longer period of follow-up duration[2]. This study only dealt with short-term outcomes, which makes it difficult to reach to shunt failure rates in our set up. Long-term follow up requires a few years of data collection and acceptable follow-up rates. There was a high dropout rate from follow up in this study, which introduces bias on the overall outcome and mortality rates.

Our definition of "good outcome" as the absence of seizures, motor difficulties, or visual problems, decrement in head circumference, soft fontanelle is at best an assumption, since intellectual development and QOL include multiple other unmeasured factors. Our follow-up was short and middle term.

Conclusion

In a developing country such s Ethiopia, clinical symptoms and signs and cranial ultrasound are sufficient for the diagnosis and management of children with hydrocephalus. Spina bifida was main etiological cause of hydrocephalus in our setting.

Our study done in a resource-limited African setting has documented good outcomes at 6 months follow-up period for VP shunt insertion with acceptable early complication rates. However, children with a head circumference greater than 50 cm had significant early complication.

Recommendation

The association of neural tube defects with hydrocephalus also mandates their prevention. Advocacy of all stakeholders for food fortification with folate is highly recommended. Alternative methods of treatment like ETV need to be strengthened in the training of residents who are major players in the treatment of children with hydrocephalus.

Given the significant complication rates of VP shunts, ETV presents an attractive option in the management of hydrocephalus. Shunts, on the other hand are widely available and effective in the management of hydrocephalus. Considering the availability of reasonably priced or even fully subsidized VP shunts, and use of ETV is limited by expensive equipment and a paucity of available expertise, shunts will continue to play a pivotal role in the management of hydrocephalus in Ethiopia.

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