

Original Research Article

Ventriculoperitoneal (VP) Shunt Surgery and their Complications in Children: A Prospective Observational Study

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Abstract: Background: Ventriculoperitoneal shunting is the main technique for extra-theal cerebrospinal fluid (CSF) diversion. Even though VP shunts are the standard of care for many types of hydrocephalus, they tragically have many problems that require surgery more frequently than initial shunt insertions. The objective of this study was to analyze the hydrocephalic children who had undergone Ventriculo peritoneal shunt surgeries with regard to the etiology, clinical profile and complication. **Methods:** This is a prospective observational study that was conducted at department of Pediatric Neuro Surgery, Bangladesh Shishu Hospital & Institute (BSH&I) for a period of 5 years from January 2017 to January 2022. This study included 92 patients out of 240 patients of hydrocephalus (HCP) who underwent VP shunt placement and had complications. **Results:** A total of 92 patients (38.3%) out of 240 patients who presented with various patterns of complications over the period of the study were examined. The average age was 15.5±8.1 months, with 62 (67.4%) male and 30 (32.6%) female and mortality rate was 4.2%. 75 (81.5%) of the 92 patients experienced single complication, while the remaining 17(18.5%) had multiple complications. Forty-five (48.9%) patients had ventricular end malfunction and 26 (28.3%) patients had peritoneal end malfunction, 21(22.8%) patients had both ventricular and peritoneal end malfunction. Patient of early infective complications were 24(26.1%) and late infective complications were 6(6.5%). Moreover, numbers of early and late mechanical complication were 25(27.2%) and 37(40.2%) respectively. **Conclusion:** Pediatric patients frequently experience difficulties from VP shunts despite the best efforts of neurosurgeons worldwide to reduce these issues. A great care should be taken during insertion of the shunt system starting from scrubbing to avoid complications. Despite complications, the VP shunt remains the main surgical procedure used for hydrocephalus management.

Keywords: Ventriculoperitoneal (VP) Shunt, Hydrocephalus, Extra-theal Cerebrospinal Fluid (CSF).

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INTRODUCTION

Hydrocephalus is a spare of cerebrospinal fluid (CSF) in the ventricular system due to the imbalance between formation and absorption of CSF which is referred to (i) obstruction of the CSF pathways, (ii) over production of CSF, and (iii) impaired venous drainage [1]. This is the second most common congenital brain

malformation [2]. The ventriculoperitoneal shunt (VP) is a common treatment for hydrocephalus (HDC), a condition of the brain brought on by an excessive generation or impaired absorption of cerebrospinal fluid (CSF), which causes dilatation of the ventricular system [3, 4]. In 1908, Kausch invented the method of ventriculoperitoneal shunting (VP), which involves

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utilizing the peritoneal cavity for CSF absorption [5]. Although VPS insertion is a routine neurosurgical surgery, adult complication rates are poorly understood and have been reported to range from 17 to 33% [6-11]. When compared to adults, children had a greater rate of shunt problems at 5 years (48 versus 27%, $P < 0.0001$) [12]. The main risks associated with VP shunt include mechanical issues, placement issues, infections, CSF leaks, and, intracerebral haemorrhage. Additionally, peritoneal catheter complications like ileus, pseudocyst formation, and bowel perforation can lead to shunt failure [2, 5, 13-15]. If a shunt system fails to be operated correctly, the patient's life and cognitive functions are placed at risk. Thus, an urgent revision must be done [16]. The present study is a prospective analysis of hydrocephalic children who had undergone Ventriculoperitoneal shunt surgeries with regard to the etiology, clinical profile and complication.

OBJECTIVE OF THE STUDY

The objective of this study was to analyze the hydrocephalic children who had undergone Ventriculoperitoneal shunt surgeries with regard to the etiology, clinical profile and complication.

MATERIALS & METHODOLOGY

This is a prospective observational study that was conducted at department of Pediatric Neuro Surgery, Bangladesh Shishu Hospital & Institute (BSH&I) for a period of 5 years from January 2017 to January 2022. Total 240 patients of hydrocephalus (HCP) who underwent VP shunt surgery and 92 patients had complications. An informed signed consent was taken from the parents and guardians of patients before enrolling them into the study. During the study period, a complete clinical assessment including a detailed history and examination with a particular emphasis on neurological examination was done for all patients after admission. The investigations performed for all patients were complete blood count (CBC), erythrocyte sedimentation rate (ESR), C reactive protein, Serum creatinine, Serum electrolytes, complete urine analysis, X-ray chest, and brain computed tomography (CT) scan or MRI. Specific investigations such as CSF analysis, CSF culture and sensitivity, blood culture and sensitivity, urine culture and sensitivity, pus culture and sensitivity, ultrasound of abdomen, shunt series X-rays, and MRI of the brain were also performed when indicated. A final diagnosis was made on the basis of clinical findings, investigation, and treatment of individual patients was planned accordingly. All patients with VP shunts who had one or more complications were included in the study. Statistical analysis Data was recorded and analyzed using the Statistical Package of Social Sciences (SPSS) version 20. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations.

RESULT

A total of 92 patients (38.3%) who presented with various patterns of complications over the period of the study were examined. The average age was 15.5 ± 8.1 months, with 62 (67.4%) male and 30 (32.6%) female and mortality rate was 4.2% [Table:1]. 75 (81.5%) of the 92 patients experienced single complication, while the remaining 17(18.5%) had multiple complications [Figure: 1]. The causes of hydrocephalous patients were aqueductal stenosis 39 (42.4%), post- meningitis 22(23.9%), post-myelomeningocele 17(18.5%), Dandy Walker malformation 7(7.6%), post-intra ventricular haemorrhage (IVH) 4(4.3%), and post-encephalocele repair 3(3.3%) [Figure: 2]. 76 (82.61%) patients had increasing head size, 67(72.83%) had splayed cranial sutures, 25(27.17%) had setting sun sign, 40(43.48%) had tense anterior fontanelle and 17(18.48%) had meningomyelocele. A few of them presented with vomiting, headache, refusal to feed, fever and convulsions [Table: 2]. Infective complications include shunt tract abscess 11(36.7%), CSF leak 5(16.7%), exposure of shunt tube through anus 2(6.7%), seizure 4(13.3%), wound infection 5(16.7%), scrotal swelling 3(10%) [Figure: 3]. Forty-five (48.9%) patients had ventricular end malfunction and 26(28.3%) patients had Peritoneal end malfunction, 21(22.8%) patients had both ventricular and peritoneal end malfunction. Patient of early infective complications were 24(26.1%) and late infective complications were 6(6.5%). Moreover, numbers of early and late mechanical complication were 25(27.2%) and 37(40.2%) respectively. Twenty-four patients had a history of shunt revision, out of which 16(66.7%) had undergone revision of shunt once, 3(12.5%) had undergone revision twice and 5(20.8%) patients had undergone multiple shunt revision. On analyzing the nature of complication in respect to infective shunt complication interval, mean shunt complication interval in patients with infective complication was 16.2 ± 12.44 months compared to 50.42 ± 32.74 months in patients with mechanical complication [Table: 3].

Table 1: Demographic Characteristic of the study patients

Age (in month)	Frequency	Percentage
≤5	9	9.78
6-10	12	13.04
11-15	10	10.87
16-20	18	19.57
21-25	14	15.22
26-30	13	14.13
31-35	16	17.39
Mean±SD	15.5±8.1	
Male	62	67.4
Female	30	32.6
Mortality	10	4.2

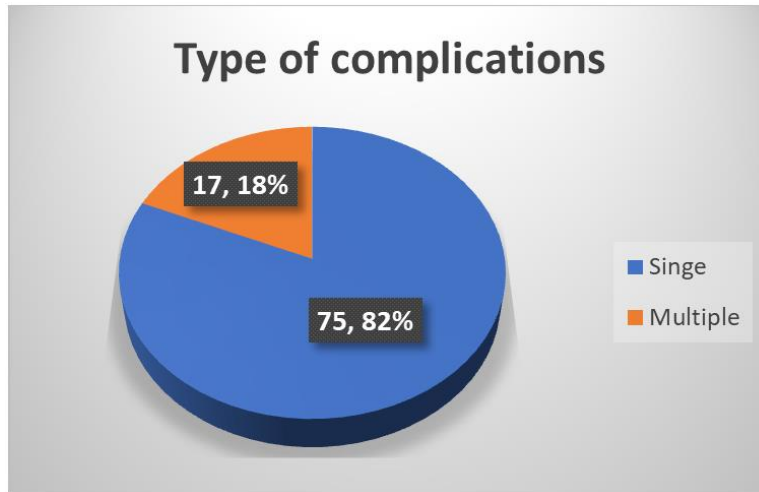


Figure 1: Type of complications

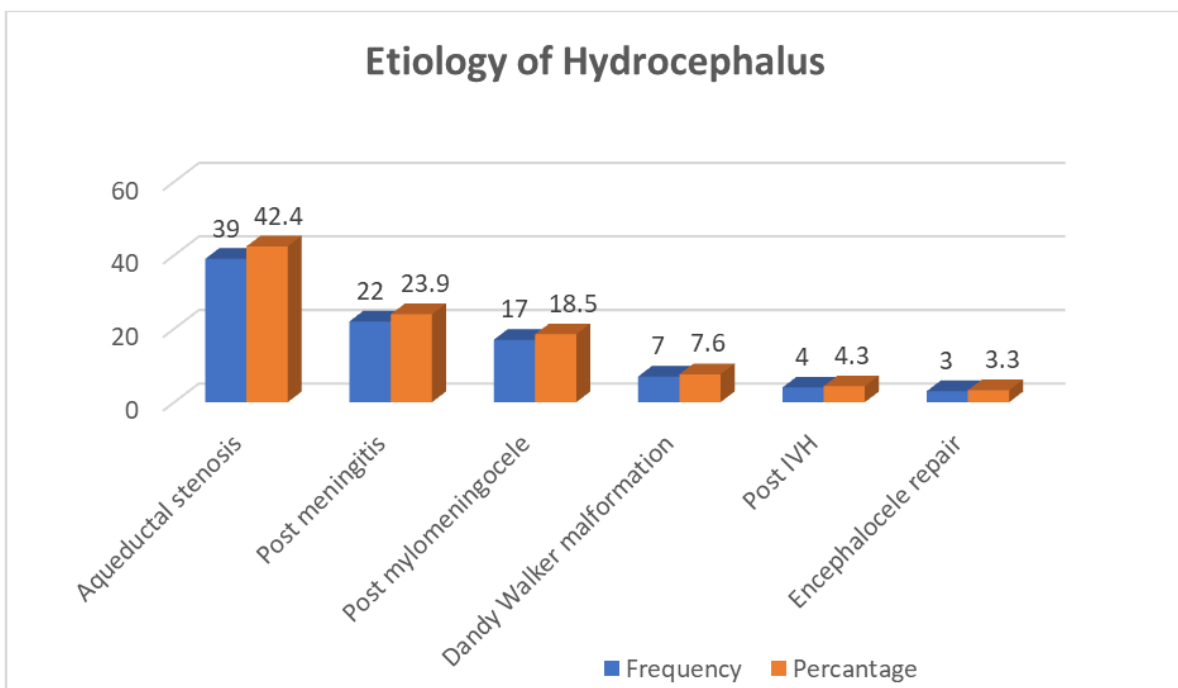


Figure 2: The Etiology of Hydrocephalus

Table 2: Clinical presentation of the study patients

Clinical Presentation	Frequency	Percentage
Symptoms		
Asymptomatic	32	34.78
Vomiting	17	18.48
Headache	16	17.39
Fever	15	16.30
Refusal of feeds	4	4.35
Decreased activity	4	4.35
Convulsions	4	4.35
Signs		
Increased head circumference	76	82.61
Splayed cranial sutures	67	72.83
Sunset sign	25	27.17
Tense anterior fontanelle	40	43.48
Meningomyelocele	17	18.48

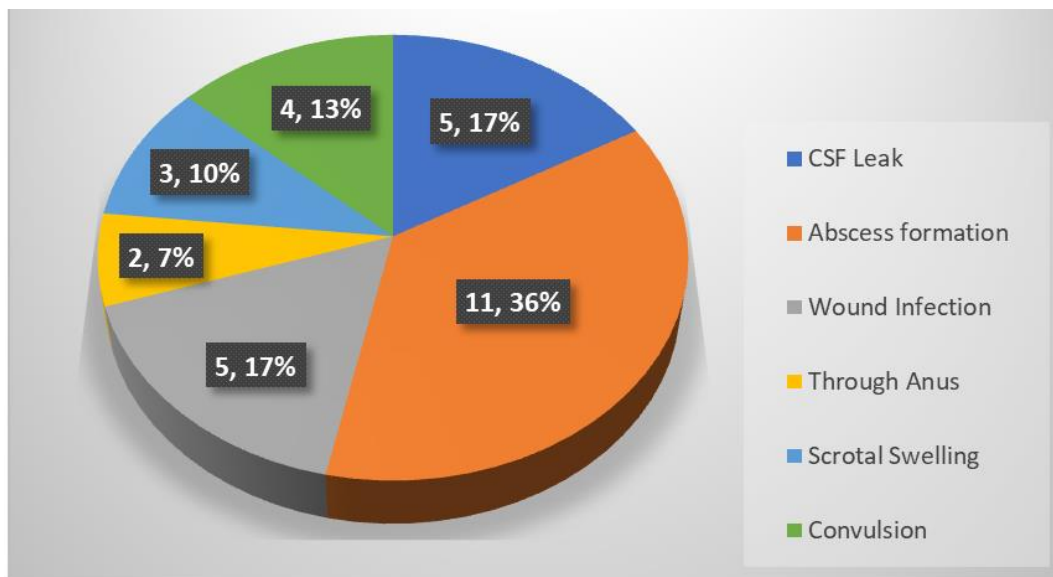


Figure 3: Infective complications of VP shunt

Table 3: Distribution of data of VP shunt complication

Complications		Frequency	Percentage
Shunt malfunction	Ventricular end	45	48.9
	Peritoneal end	26	28.3
	Both ventricular & peritoneal end	21	22.8
Shunt complication	Infective	30	32.6
	Early	24	26.1
	Late	6	6.5
	Mechanical	62	67.4
	Early	25	27.2
	Late	37	40.2
Shunt revision	Single	16	66.7
	Twice	3	12.5
	>Twice	5	20.8
Shunt complication interval (month)	Infective (Mean ±SD)	16.2±12.44	
	Mechanical (Mean ± SD)	50.42±32.74	

DISCUSSION

There are hundreds of thousands of VP shunts placed worldwide every year. Although VP shunt is an effective treatment of hydrocephalus, it is plagued by shunt-related complications [17]. As indicated in figure 2, the etiology of hydrocephalus was divided into congenital and included Dandy-Walker Syndrome, myelomeningocele, secondary to intraventricularhaemorrhage (IVH), and aqueductal stenosis (AS). Congenital hydrocephalus has been the most prevalent etiology in the developed world, although post-infectious causes have been found at very high rates in the poor world. Aqueductal stenosis caused by congenital abnormalities makes up around 10% of all paediatric occurrences of hydrocephalus [18]. The most frequent causes were congenital aqueductal stenosis (n = 39, 42.4%), according to our analysis. Males account for 67.4% of the 92 complicated patients in the current investigation, which was consistent with the findings of most studies that found VP shunt issues are more common in men than in

women [19]. Children who were younger at the time of their first shunt installation are more likely to experience shunt issues. This is in line with the findings of Abdul Munam *et al.*, who conducted their investigation on 40 patients with difficult VP shunts, where children made up 85% of the patients [20]. In the present study, the rate of complications was 38.3%, and 18.5% of problematic patients had multiple issues that need treatment beyond surgery and 4.2% of people died. Alexander *et al.*, reported a decreased incidence of complication rate in a 4-year study over 17035 patients at one of California's hydrocephalus facilities from 2005 to 2012, while the rate of problems was 33.4% and 2.7% mortality rate. According to the findings of their study, there hasn't been a material change in the rate of VP problems over the past few decades, which was 28.7% according to a study conducted at the same center from 1970 to 1988. Another study from 1990 to 2000, conducted 15 years later, revealed a 29% complication rate [21]. In their study of 253 pediatric patients with congenital hydrocephalus, Nortarianni *et al.*, showed that complications occurred in 78% of cases

whereas deaths occurred in 1.6% of cases over a 3-year period, indicating a greater complication rate [22]. In our entire series, 12.5% of the problems were infectious, and 25.8% were mechanical. Whereas Lee *et al.*, showed 12.2% shunt blockage and 4.1% infection, Kanashaet *al.*, found similar results with 32% mechanical and 14.6% infectious causes [23, 24]. In their study, Peacock and Career discovered a 20% shunt blockage rate [25]. According to Lohani *et al.*, 12.07% had shunt malfunction and 7.92% had shunt infection [26]. In our study, 52.15% patients with shunt-related problems manifested after two years and 32.12% within six months following shunt implantation. A review of the literature revealed that event-free survival varied between 62% and 80% after one year and between 35% and 48% at ten years [27-29]. Mortality related to shunts was 20% in the study by Kanashaet *al.*, [23], whereas it was 4.2% in our analysis. Non-tumorigenic hydrocephalus has a fatality rate that ranges from 8.6% to 13.7%, according to the numerous studies that have been published in the literature. The figure varies depending on the amount of follow-up in various studies [30, 31]. We believe that by tightening up our setup's technical and sterilising procedures, we can decrease postoperative mortality and morbidity. This belief is based on the discussion.

CONCLUSION

Pediatric patients frequently experience difficulties from VP shunts despite the best efforts of neurosurgeons worldwide to reduce these issues. Mechanical complication is the most frequent, followed by shunt infections. Despite problems, the VP shunt is currently the main surgical procedure used to treat hydrocephalus. This study suggests that in order to restrict or prevent shunt problems, the VP shunt system should only be implanted by trained neurosurgeons. The shunt system should be inserted carefully and safely and starting with cleaning, to avoid problems like infection.

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