



Thirty days complications of pediatric hydrocephalus following ventriculoperitoneal shunt surgery

Sukriti Das¹, Asifur Rahman², Haradhan Deb Nath³, Rathin Halder⁴, Dipankar Ghosh⁵

¹ Associate Professor, Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

² Associate Professor, Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

³ Professor, Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

⁴ Resident, Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

⁵ Resident, Department of Neurosurgery, Dhaka Medical College & Hospital, Dhaka, Bangladesh

Abstract

Background: Ventriculoperitoneal shunt (VPS) is one of the commonest procedures in neurosurgical practice for the treatment of hydrocephalus (HCP) in pediatrics, especially in developing countries. Despite being widely used, VPS is still plagued with several complications, so needed repeated interventions. Thereby increase hospital stay, morbidity, and mortality. The majority of the complications were observed in the early postoperative period but over time, the rate of complications decreases. So we conducted this study to identify the complications within 30 days following VPS in children.

Materials and Methods: This prospective interventional study was conducted in the Department of Neurosurgery, BSMMU, between January 2019 and January 2020. Children aged 1 month to 5 years, who underwent VPS surgery for the first time were included in this study. Following VPS operation, patients were given regular follow-up for one month, either through the Telephone or asked to visit the outpatients on the specified days. During follow up all patients were evaluated for shunt-related complications. Then the data were analyzed using the SPSS version 26. Results are presented in the form of tables.

Results: We evaluated a total of 120 patients, during the study period, there were 75 (62.5%) males and 45 (37.5%) females with a male to female ratio approaching 1.6:1. Patients aged from 1 month to 5 years (60 months). The indications of VPs surgery were: congenital hydrocephalus in 70 (58.3%), post-infectious hydrocephalus in 15 (12.5%), hydrocephalus due to tumor in 30 (25%), and post-traumatic hydrocephalus in five (4.16%) patients. During the follow-up, complications were encountered in 30 patients (25%). Complications observed between day 1 and day 30 during follow-up were shunt malfunction (blockage, cranial or caudal migration, misplacement) 8(6.66%), shunt infections 10 (8.33%), CSF leakage 3(2.5%), ileus 5 (4.16%), convulsion one(0.83%), gut perforation one (0.83%) and abdominal complications 2 (1.6%) among 120 patients.

Conclusion: VP surgery is very prone to complications and in our study, almost every fourth case of VPS arises complications. Shunt malfunction due to blockage, infections, and abdominal wound-related complications are common earlier in pediatric patients with hydrocephalus.

Keywords: hydrocephalus, ventriculoperitoneal shunt

Introduction

Ventriculoperitoneal shunt (VPS) is a commonly performed procedure in developing countries for the management of hydrocephalus in children. The imbalance between formation and absorption of CSF causes an excess amount of cerebrospinal fluid (CSF) to accumulate in the ventricular system resulting in dilatation of the ventricular system referred to as hydrocephalus^[1, 2]. In the United States, approximately 36,000 shunt procedures were performed annually, which costs \$94 million per year^[1, 2]. A CSF diversion implant, usually a catheter with a pressure-regulating valve system used in VPS surgery which introduces the ventricular system and brings CSF to an absorptive surface outside the brain such as the peritoneum^[2]. The other common shunt procedures are ventriculoatrial and ventriculopleural shunt, where the shunt system brings CSF to the vascular system and pleura, respectively^[2, 3]. VP shunt operation aims to relieve excess intraventricular CSF there by intracranial pressure (ICP) due to hydrocephalus^[1-3, 5].

Shunt placement failure, mechanical malfunction due to shunt blockage, cranial or caudal migration, displacement, infection, CSF leak are the most common complications^[3, 5-7]. Rare complications include abdominal catheter-related complications such as abdominal pseudocyst, ileus, and gut perforation, resulting in shunt failure^[3, 5, 6, 8, 9]. Shunt failures are observed about 14%, within the first four weeks of surgery, and approximately 40-50% of VPS will fail within one year^[3]. Shunt failure rate relatively high (29%) within the first year in adults. About 45 to 59% of all patients, irrespective of age, will require a shunt revision. Infections and shunt failure are common, and 48% of patients required shunt revision following shunt surgery^[3, 6, 7]. VPS operation is one of the most commonly performed procedures in the neurosurgical department, particularly in children. But they are more prone to develop complications^[3, 6, 9-12] and the majority of the complications are witnessed in the immediate postoperative period^[3, 6, 11, 12]. So our study aims to find complications of VPS operation within 30 days,

in the pediatric population operated at our department.

Materials and Methods

This is a prospective interventional study, conducted by the Department of Neurosurgery, BSMMU, Dhaka between January 2019 and January 2020 (Twelve months). Patients with hydrocephalus due to various etiology aged 1 month to five years (60 months) who underwent initial VPS surgery were included after taking informed consent. Sampling was achieved via consecutive non-probability sampling. Patient age greater than 5 years, shunt revision, expired patients, and lost to follow-up during this study period were excluded from the study. Patients’ details like age, sex, address, mobile number, etiology of hydrocephalus, type of surgery (elective or emergency), Date of shunt placement were noted on a predesigned data collection sheet. After surgery, patients were followed for 30 days, and contacted either through the telephone or asked to visit the outpatients on the specified days, and were evaluated for any shunt-related complications. Patients with complications were further evaluated and noted. The data were analyzed using the statistical program SPSS version 26.

Results

During the study period, we evaluated a total of 120 patients; there were 75 (62.5%) males and 45 (37.5%) females with a male to female ratio approaching 1.6:1 (Table 2) The age range was from 1 month to 5 years (60 months). The minimum age was 30 days and the maximum age was 5 years (60 months). There were 65(54.16%) patients age group of 1-12 months representing the majority, and 35 (29.16%) patients were in the age group of 13-24 months, while there were 20 (16.66%) patients between 25-60 months of age (Table 1). Regarding the primary indications for the insertion of VP shunt, there were congenital in 70 (58.3%) patients in the form of aqueductal stenosis, patients with myelomeningocele and Dandy-Walker syndrome. There were 15 (12.5%) post infectious cases including post meningitic and tuberculous meningitis (shunt was placed after a clear CSF with no neutrophils and decreased proteins), and hydrocephalus due to the tumor was found in 30 (25%) patients. Five patients (4.16%) were having hydrocephalus related to the trauma, i.e., post-traumatic hydrocephalus; all are summarized in Table 3.

Table 1: Distribution of patient according to age group (n=120)

Age groups	Frequency	Percentage
1-12 months	65	54.16
13-24 months	35	29.16
25-60 months	20	16.66

Table 2: Distribution of patient according to Gender (n=120)

Gender	Frequency	Percentage
Male	75	62.5
Female	45	37.5

Table 3: Distribution of patient according to indication of VP shunt (n=120)

Etiology	Frequency	Percent
Congenital	70	58.33
Infectious	15	12.5
Tumor	30	25
Post trauma	5	4.16

The operations were done either by consultants or senior residents. Patients were followed for one month regarding any complications like shunt malfunction, infections, CSF leaks, seizures, ileus, gut perforation, and other abdominal complications like the exposure of the distal catheter, extrusion through the anal canal, and/or placement of the catheter outside the peritoneal cavity. Complications were encountered in 30 patients (25%) during the follow-up of 30 days. Shunt malfunction due to the blockage of the ventricular catheter, cranial migration, dislodgement (Figure 2), detachment, displacement (Figure 1) or knotting was present in 8(6.66%), infection (Figure 4) in 10 (8.33%), CSF leak (Figure 3) in 3(2.5%), ileus was in 5 (4.16), seizures were in one(0.83%), and one(0.83%) bowel perforation (Figure 6), complications pertinent to the abdominal catheter (Figure 5) were present in 2 (1.6%) patients as shown in Table 4.

Table 4: Frequency of various complications related to ventriculoperitoneal (VP) shunt in pediatric patients (n=30)

Complications	Frequency	Percent
Malfunction	8	6.66
Infection	10	8.33
CSF leak	3	2.5
Ileus	5	4.16
Seizures	1	0.83
Bowel perforation	1	0.83
Abdominal complication	2	1.66

Complications occurred between day 1 and day 30 of follow-up. Complications like seizures and ileus were evident early whereas infections, malfunctions, and peritoneal catheter-related complications were revealed later. The patients in age group 1-12 months (65 patients) were having 17 (26.15%) complications; there were 11 (31.42%) complications out of the 35 patients in the age group 13-24 months and two (10%) complications occurred in the age group 25-60 months among 20 patients, as shown in Table 5.

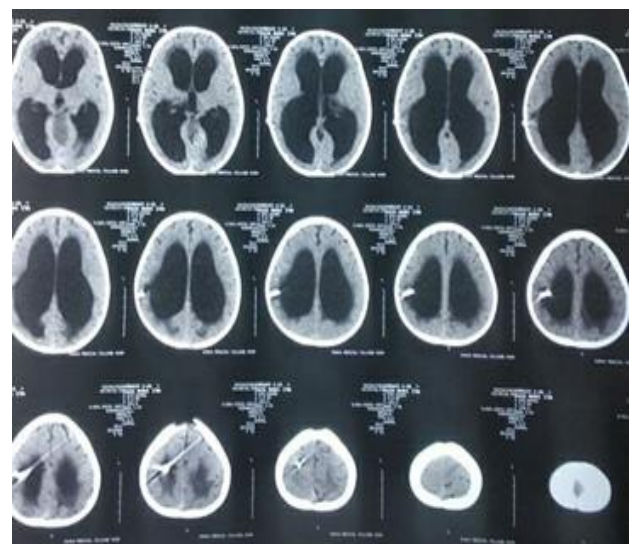


Fig 1: Misplaced catheter



Fig 2: CSF collection due to shunt dislodgement



Fig 3: Exposure of the reservoir due to infection



Fig 4: Subgaleal CSF Collection

Table 5: The distribution of documented complications among different age groups

Age group (months)	Malfunction	Infection	CSF leak	Ileus	Seizures	Gut perforation	Abdominal Pseudocyst	Total	Percent
1-12	4	6	2	3	0	1	1	17	56.66
13-24	3	3	1	2	1	0	1	11	36.66
25-60	1	1	0	0	0	0	0	2	6.66

Table 6: The distribution of documented complications among different etiology

Etiology	Malfunction	Infection	CSF leak	Ileus	Seizures	Bowel perforation	Abdominal Pseudocyst	Total	Percent
Congenital	4	5	2	2	1	1	1	16	53.33
Infectious	3	3	1	1	0	0	0	8	26.66
Tumor	1	1		1	0	0	1	4	13.33
Post trauma	0	1	0	1	0	0	0	2	6.66

Stratification of the complication among the indications for surgery revealed that 16 patients (22.85%) were operated on for congenital hydrocephalus, 8 patients (53.33%) were operated on for infectious causes and four (13.33%) patients were operated on for tumor-related pathology and 2 patient (40%) complication occurred in posttraumatic HCP patients.



Fig 5: CSF discharge through abdominal end



Fig 6: Bowel perforation and extrusion through anus

Discussion

For pediatric patients with hydrocephalus, the primary management option is the implantation of a VPS as an effective CSF diversion technique. Nonetheless, this is the procedure of choice for treating infants because its success rate is greater than that for endoscopic third ventriculostomy (ETV) [2-4, 9-11]. However, VP shunt surgeries are commonly done in developing countries like ours, where shunt infections are common in pediatric patients and endoscopy is not a good option for them [11, 12]. However, this widely used procedure has many post-operative complications. [5, 6, 8-10, 13, 14]. In this study, it was found that males are slightly higher than females. Although hydrocephalus is not gender-specific and does not make specific genders susceptible to hydrocephalus, some studies have shown that for unknown reasons, there is a male predilection for hydrocephalus [9, 11-15]. The age range for VP shunt placement is 30 days to 5 years old. Most patients in this study group were infants (47%). And because many studies have reported complications rate higher in infants compared with older age groups [3-6, 11-13], we also carried out age assessments based on 1-12 months, 13-24 months, and 25-60 months. Cambrin *et al.* reported that under six months of age made up the majority of complications encountered in their series, 1.55%. Etiologically, hydrocephalus has been classified as congenital, including Dandy-Walker Syndrome (DWS), myelomeningocele (MMC), aqueduct stenosis (AS), any other congenital cystic abnormality that causes hydrocephalus, or tumor-related post-infectious HCP, as shown in HCP and post-traumatic HCP, as shown in HCP Table 4.

As shown, the most common etiology in developed countries was congenital hydrocephalus, while in developing countries it was reported post-infectious at a very high level. In this study, congenital and tumor-related HCP were found more than other etiology.

Despite many advances in other areas of medicine, the shunt-related complication rates are static and are around 30% with an overall long-term shunt failure rate of up to 46% [15, 16-18]. Instead, we found an overall complication rate of only 25 patients (n = 30), but this reflects a complication rate of one month and is expected to be higher with long-term follow-ups.

This current study found infection rate is between 3% and 12% and it is higher in infants than in adults [5-7]. The infection can occur at any time from days to months with a median of one month [19, 20]. Infection rate of 8.33% (n = 10) in a certain period, comparable to studies in developed countries [21]. Shunt malfunction was noticed in 6.66% of cases (n = 8), is still the most common complication of shunt insertion, and is the main reason for shunt revision [3, 20-22]. A study by Ghritlaharey *et al.* [22] reported that the incidence of CSF leakage was 1.7% and complications related to the abdominal catheter was 13% (18/236 patients), while in our study we found three cases (incidence of 2.5%) of CSF leakage and complications observed the abdominal catheter with 1.66% (n = 3) significantly higher than in the previous study. We also observed recently developed seizures after shunt placement in 0.83% of patients (n = 1). Seizures remain a major problem in patients undergoing a VP shunt, 31 to 69% of shunt patients have a history of seizures, and shunt dysfunction itself predisposes the patient to seizures [2, 3]. Electroencephalogram (EEG) changes, including specific focal paroxysmal discharges accompanied by slow waves,

have been observed in the area of the ventricular catheter and are thought to be associated with cortical injury during shunt placement [23, 24]. Shunt complications are influenced by age [12-14, 16-18]. We divided our patients into three age groups, 1-12 months was the most prone to develop complications at the rate of 56.66% (n = 17) followed by 36.66% (n = 11) complication rate for 13-24 months. Children 25-60 months had a lower complication rate of 6.66% (n=2), which is supported by previous studies performed by Reddy *et al.* [15], though Davis *et al.* reported that no significant difference in the shunt survival based on age in the infants [17]. Some studies found that a significant relation between shunt-associated complications and the etiology of hydrocephalus [3, 7, 17-23]. In the current study, we also found a significant relation, with congenital hydrocephalus being the highest in shunt-related complications (53.33%), followed by infectious cause of hydrocephalus (26.66%), tumor-related HCP was 13.33% while post-traumatic was the least with 56.66%.

Conclusion

VPS is the most widely used treatment for HCP, but it is predisposed to complications and almost one in five cases of VP shunt represented complications in this study. Shunt blockages, infections, and complications related to the abdominal injury are common early complications in pediatric patients with hydrocephalus which requiring revision of the shunt. Other less common complications include CSF leakage, seizures, and ileus, which can complicate a VPS procedure in the early postoperative period. Age has some impact on the risk of these and most children who may need these procedures are infants.

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