

# Repeated Malfunction of Shunt Contains Plethora of Surgical Procedures: The Institutional Based Study

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## ABSTRACT

**Objective:** To highlight the course of management that patient went through with multiple episodes of shunt failure and its associated morbidity or mortality

**Methodology:** The patients were included who have repeated shunt failure by highlighting some arbitrary predictors. Patient was not followed but admitted again and again with active hydrocephalus in neurosurgical ward. The exclusion of patients, who have shunt exposed through natural orifices.

**Results:** Total number of 31 patients were included and mostly 35.5% were less than 1 year & 35.5% were the age >10 and as the age increases, number of procedures also increases and outcome decreases (0.006). The cause of shunt placement was mainly hydrocephalus (61.3%) and 80.6% patients have right sided placement. 51.6% of shunts was performed in 2020 and mostly Indian shunt 83.9%. Surgical procedures include immediate removal of shunt (32.3%), revision of lower end (19.4%), revision of upper end (32.3%), external ventricular drainage (22.6%), endoscopic third ventriculostomy (41.9%), complete shunt revision (35.5%), externalization at lower end (22.6%), externalization at neck (22.6%) and placement of same shunt (25.8%).

**Conclusion:** The problems that shunt holds not only include over-drainage or under drainage but it also creates ripples of events. Once the malfunction occurs; the sequence continuous to occur besides changing of hardware.

**Keywords:** Hydrocephalus, Morbidity, Mortality, Shunt revision, Shunt malfunction,

### Authors' Contribution:

<sup>1,2</sup>Conception; Literature research; manuscript design and drafting; <sup>2,3</sup>Critical analysis and manuscript review; <sup>5,6</sup>Data analysis; Manuscript Editing.

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## Introduction

Excessive cerebrospinal fluid (CSF) can cause multiple neurological issues and potentially lead to drastic complication even death. CSF diversion methods are necessity to maintain good healthy liveable life and minimize prevent complications.<sup>1</sup> The introduction of shunt placement procedures in

the late 1980s and early 1990s revolutionized the treatment of excessive cerebrospinal fluid (CSF). These procedures channels the pathway to drain excess CSF from the brain ventricles into the peritoneal cavity, maybe choice in to the cardiac atrium, or the pleural cavity.<sup>1,2</sup> Although shunt placement is a transformative procedure, it has a high failure rate of 40-50% in

children and 30% in adults. In Pakistan, the reported prevalence of shunt malfunction is 10.7%.<sup>3</sup> The failure rate quoted to be 11 to 40% in first year after placement of shunt and 4.5% per year subsequently.<sup>4</sup>

Multiple causes of shunt malfunction have been speculated in literature that are associated with shunt obstruction, its mechanical failure, over drainage resulting in slit ventricle syndrome, pseudocyst formation and abdominal complication.<sup>5</sup> The shunt revision incidence is much more common in paediatric age group as compare to adults.<sup>6</sup> It has been reported that 17% of shunted patient readmitted at least once and 20.7 to 46.3% patient required shunt related surgeries on readmission with expected mortality rate of malfunction is 4.2%.<sup>4,6</sup> Shunt related surgeries include revision of new shunt, distal or proximal catheter revision or ETV. Besides, multiple shunt revisions are associated with lower survival rate as compare to shunt revision free or at least one shunt revision. The literature do emphasis on the complication and its associated outcomes but it doesn't put much effort on the number of procedures that usually performed during the course of repeated admission with expected outcome.<sup>6,7</sup> As a shunt is a foreign body in nature, these patients underwent through multiple series of procedures that it self produces profound effect on the morbidity and mortality of malfunction outcome.<sup>8</sup> The average hospital stay is 8.4 days with 50% may require more days of admissions in shunt revision patients.<sup>9</sup>

So, by highlighting such factor, it would provide us some insight for which the alternative solution should be drawn. Ventriculoperitoneal shunt is one of the magical procedures to decrease in morbidity and mortality but as a foreign body in nature its complications reported to be 30-50%. The aim of the study was to highlight the course of management that patient went through with multiple episodes of shunt failure and its associated morbidity or mortality.

## Methodology

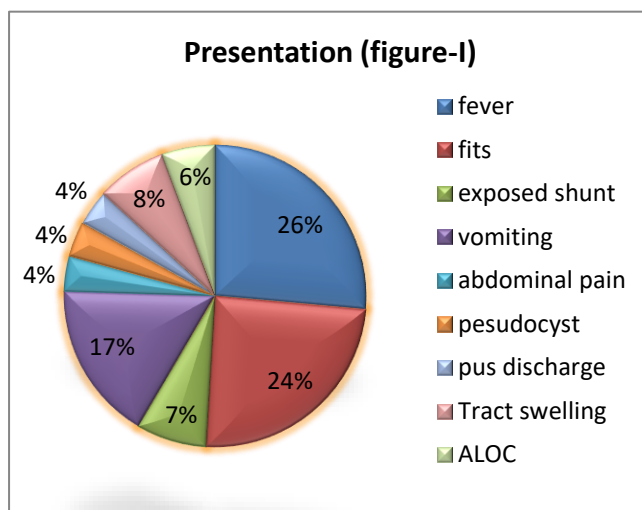
The study was retrospective in nature. The Sampling technique was Consecutive in nature. The patients that were included in the study had repeated VP shunt or failure at least once with signs of raise Intra cranial pressure. The only exclusion Criteria was the shunts that expose to external environment. Patient was not followed instead it was readmitted in our ward thorough the given time frame. CSF samples was drawn, shunt series X- rays performed and repeat CT scan brain was also performed, patient was kept on antibiotic. The medical records of surgically operated cases, previous year were reviewed. Documentation followed a specific format, capturing age, sex, clinical features, X-ray findings, cause of hydrocephalus, CT and MRI results (where applicable), as well as CSF and shunt tube culture and sensitivity tests. The study included patients of any age and sex who had previously undergone VP shunt surgical procedure and exhibited presentation of shunt-related infection. Patients without a history of shunt infection were excluded. emergency department All patients were admitted through the and underwent detailed history, examination, and neuroimaging, including brain CT and MRI scans for specific cases, as well as CSF and shunt tube culture and sensitivity tests. The shunt tube's lower end was either externalized or removed. Patients received empirical therapy with injectable 3<sup>rd</sup> -generation cephalosporin and vancomycin, later antibiotic was adjusted according to culture and sensitivity results. In the meantime, external ventricular drainage (EVD) was performed in adults and children with closed fontanels, or ventricular tapping in children with open fontanels. Once two consecutive culture and sensitivity tests were negative in three consecutive taps, the shunt was reinserted. All patients were discharged on the fourth postoperative day. Performa and results were analysed on SPSS 20 version. Patient data were collected through a pre-designed proforma, including clinical investigations such as CSF

sampling, shunt series X-rays, and repeat CT brain scans. Descriptive statistics were used to summarize demographic data, clinical presentations, and surgical interventions. Frequencies, percentages, and means were calculated to analyze the distribution of variables. Chi square test were applied to assess the association between the number of surgical interventions and patient outcomes, with significance determined using  $P < 0.05$ . Key variables such as age, cause of shunt placement, and specific surgical interventions were correlated with outcomes to evaluate their impact, with significant findings noted

This study was conducted in department of Neurosurgery, Liaquat university of medical and health sciences, Jamshoro, duration from 1<sup>st</sup> January 2021 to 30<sup>th</sup> September 2023 with **ethical approval** number LUMHS/Rec/ 337, dated 13-06-2024.

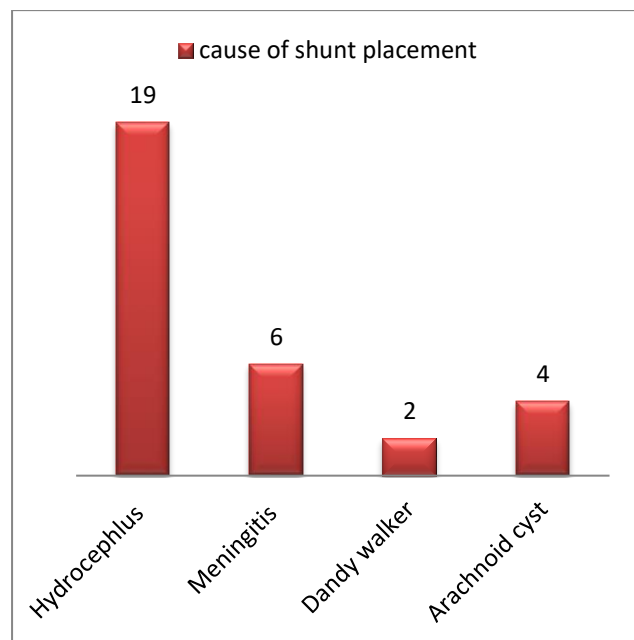
## Results

Total number of 31 patients presented within above-described time frame. Mostly male 55% with age distribution includes 35.5% patients was 2 months to <1 year and >10 years. The major cause of shunt placement was Hydrocephalus (61.3%). (Table 1)



**Figure 1: Clinical presentations with fever (26%) and fits (24%) being most common, followed by vomiting (17%) and other less frequent symptoms.**

Age of patient (P-value; 0.006)	Frequency (n)	Percentage
2 months to <1 year	11	35.5%
1 year to <5 year	9	29%
>10 years	11	35.5%
Cause of shunt placement		
Hydrocephalus	19	61.3%
Meningitis	6	19.4%
Dandy walker	2	6.5%
Arachnoid cyst	4	12.9%



**Figure 2. Causes of Shunt Placement**

The most common presentation was fits (24%), fever (26%) and vomiting (17%). (Figure.1)

The cause of shunt placement was hydrocephalus i.e., 61.3% with second major cause was meningitis (19%). (See figure 2). The Indian Shunt was mostly used that is 83.9% and the right side that is 80.6% was most common one (See Table-II)

Table II. Different types and Sites of Shunt	
Type of Shunt	
Indian	83.9%
Pudenz	16.1%
Site of shunt	
Right	80.6%
Left	12.9%
Dual side	6.5%

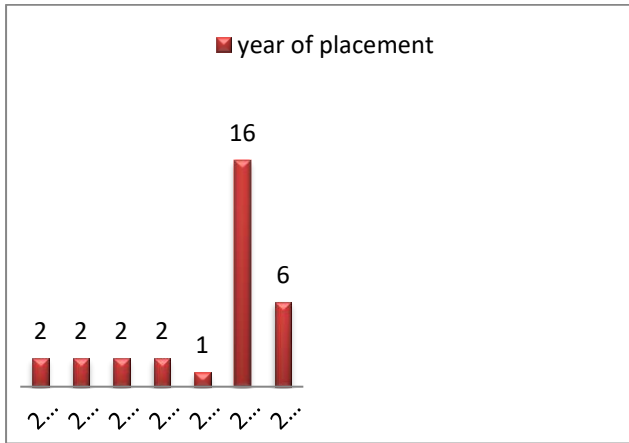


Figure 3. Years of placement

Table IV. Outcome of patients related to number of procedures		
Outcome	Number (%)	P- value
Favorable Outcome	21 (67.7%)	0.146
Expired	10 (32.3%)	

Most of the shunts was performed in 2020 i.e., 51.6% followed by 2021 (19.4%). (See Figure-III) Endoscopic 3<sup>rd</sup> ventriculostomy was performed mostly (41.9%) in patients that presented with malfunction. Revision of whole shunt (35.5%) was the second procedure on the list (Table-III). The effect on the outcome was not observed significantly. The cross tabulation was performed between surgical intervention as categorical variable and outcome via Chi square test. patients expired. The P- value is calculated when data is correlated with number of procedures and outcome of patient In our study, we had 31 patients, the age distribution was as follows: 11 patients were under one year old;

(more than 2 categories), the p value was calculated via kruskal wallis test and it shows increasing the data is correlated with number of procedures (Table IV) The Mean of 2.55 Procedures was performed, with two Procedures performed 32.3% mostly and 25.8% procedure performed once.

Table III. Shunt related procedures with its impact on Outcome			
Surgical intervention	Favourable outcome (N)	Expired (N)	P- value
Removal of Shunt*	5	5	0.145
Revision of lower end	3	3	0.301
Revision of upper end	7	3	0.853
Revision of whole shunt	5	6	0.049
Endoscopic 3 <sup>rd</sup> Ventriculostomy	9	4	0.880
External Ventricular Drain	4	3	0.495
Externalization at neck	2	5	0.012
Externalization at lower end	5	2	0.813
Placement of same shunt	5	3	0.713

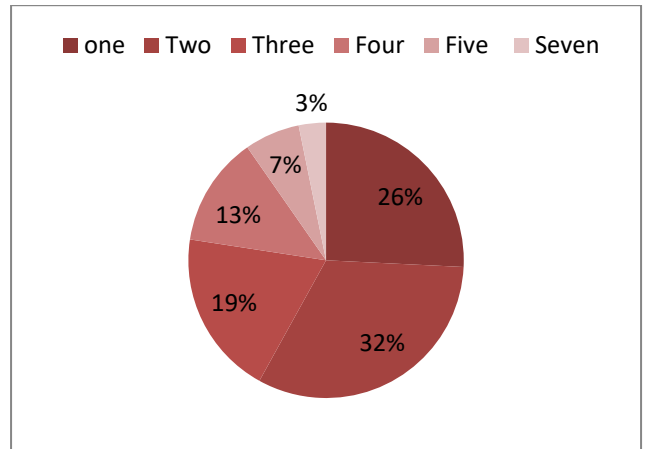


Figure 4. Number of Procedures

## Discussion

nine patients were between 1 and 5 years old, and 11 patients were over 10 years old. The primary

reason for placing a shunt was hydrocephalus in 19 patients, followed by meningitis in 6 patients, and dandy-walker and arachnoid cysts in the remaining cases. The most common presenting symptoms were fever, seizures and nausea/vomiting. The Indian shunt was the most commonly used shunt type, accounting for 83.9% of cases. Additionally, the right side was the most frequent shunt placement site, occurring in 80.6% of cases. Endoscopic third ventriculostomy was performed in 41.9% of patients who presented with shunt malfunction, while whole shunt revision was the second most common procedure, performed in 35.5% of cases. Regarding patient outcomes, 67.7% of patients had a favourable outcome, while 32.3% of patients passed away. The effect on the outcome was not observed to be significant. The mean number of procedures per patient was 2.55, with two procedures performed in 32.3% of cases and one procedure performed in 25.8% of cases. Overall, the study indicates a relatively high rate of favourable outcomes, but there is room for improvement in reducing patient mortality and complications associated with shunt procedures.

Study have shown that most common cause causative organism of shunt infection in children was coagulase negative staphylococci is the most common.<sup>10,11</sup> In another study, the study identified several risk factors linked with increased risk of shunt infection. These risk factors included younger age, prior shunt infections, undergoing surgery during the current hospital stay, shunt removal or replacement, prior shunt revisions, current complications, and the presence of fever.<sup>12</sup> while in our study the common reason was young age, infection of chest or urinary infection, but the time lapse was at least more than five years.

The marked decline in the effectiveness of carbapenem and beta-lactam/beta-lactamase inhibitor combination drugs against common Gram-negative bacteria causing VP shunt infections highlights the urgent need for alternative antibiotic treatments. Medications such as colistin,

Fosfomycin, ceftazidime/avibactam, and tigecycline should be included in testing panels for effective treatment. Implementing care bundles to prevent VP shunt infections is also recommended for better patient outcomes.<sup>13,14</sup> The use of a local vancomycin saline can substantially lower the risk of VP shunt infection. Intraoperative application of 2 mg/mL topical vancomycin (applied both in and around the shunt) as part of a multi-step shunt infection prevention program significantly decreased the rate of shunt infection. This approach may also be more cost-effective compared to using an antibiotic-impregnated catheter (AIC).<sup>15,16</sup> The standardized shunt operation technique, incorporating intraventricular and topical vancomycin, results in a shunt infection rate of 3.2% per procedure, lower than rates reported elsewhere. Most infections arise within two months of surgery, with *S. epidermidis* as the primary causative organism. Multivariate analysis found that surgeries on patients under six months old and postoperative CSF leaks significantly increased the risk of shunt infections. These results support including vancomycin in standardized protocols to prevent paediatric shunt infections.<sup>17</sup> A history of shunt revisions substantially raised the likelihood of subsequent shunt infections, but being over 5 years old offered a protective effect. Moving forward, efforts should focus on enhancing revision procedures and reducing infection risks.<sup>18</sup> Although association of hydrocephalus is not uncommon with meningomyelocele, both can be treated simultaneously as per condition of the patient.<sup>19</sup> **Limitations:** In spectrum of our study, we did not observe in core the causative organism, the follow

up of the patient and use of multiple antibiotic which should have been the part. VP shunt infection is common, it needs multicentre approach.

## Conclusion

The problems that shunt holds not only include over-drainage or under drainage but it also creates ripples

of events. Once the malfunction occurs; the sequence continuous to occur besides changing of hardware. On repeated admissions, the surgical procedures increase with it, this also increases the worsening of outcome and if the shunted patients presented beyond age 10 years, the chances are that patient will go on repeated surgical procedures in next course of treatment.

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