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Outcomes and Revision Rates Following Pediatric Ventriculoperitoneal Shunt Surgery: A Retrospective Study at Misrata Medical Center (2021–2025)

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Abstract

Background: Ventriculoperitoneal (VP) shunting is the most common treatment for hydrocephalus in children. However, shunt-related complications and revision rates remain high.
Objective: To evaluate the demographic profiles, indications, surgical approaches, complication rates, and revision causes among pediatric patients who underwent VP shunt surgery at Misrata Medical Center between January 2021 and December 2025.
Methods: This retrospective study included 144 pediatric patients who underwent VP shunt placement. Data on age, sex, indication for shunting, valve type, surgical approach, complications, and revision causes were collected and analyzed.
Results: Among the 144 patients (102 males and 42 females), congenital hydrocephalus was the leading indication for VP shunting (47.9%). A total of 49 patients (34%) required at least one revision surgery. The primary reasons for the first revision were obstruction (49%) and infection (34.7%), respectively. The majority of first revisions (63.3%) occurred within six months of the initial surgery. Infants under one year of age had a higher revision rate. The overall mortality rate was 11.8%, with higher rates observed in patients who required multiple revisions.
Conclusion: VP shunt surgery in our pediatric population is associated with a significant risk of complications, primarily obstruction and infection, leading to a high revision rate. Age under one year is a key risk factor for shunt failures. These findings underscore the need for enhanced preventative strategies and close postoperative monitoring to improve patient outcomes

I) Background:

Hydrocephalus is a common neurosurgical condition in the pediatric population, characterized by abnormal accumulation of cerebrospinal fluid (CSF). Its congenital incidence is estimated at .9-1.8 per 1000 births. [1] The condition is broadly categorized as non-communicating (obstructive) or communicating (non-obstructive) and can be congenital or acquired. Congenital causes include neural tube defects (e.g., spina bifida), aqueductal stenosis, and complications of prematurity, such as intraventricular hemorrhage (IVH). Acquired hydrocephalus can result from traumatic brain injury (TBI), brain tumors, or infections such as meningitis.

The standard treatment is the surgical placement of a ventriculoperitoneal (VP) shunt to drain the CSF. Despite being a routine procedure, VP shunting is associated with high rates of mechanical failure and infection, frequently necessitating revision surgery [2]. The common causes of shunt failure include obstruction, infection, mechanical disconnection, and patient growth. Each revision surgery carries cumulative risks, including an increased chance of subsequent infection, surgical scarring, and the potential for neurological decline [3].

Understanding the local patterns and causes of shunt failure is essential for improving surgical outcomes and guiding clinical practices. However, there is a scarcity of published data from Libyan centers. This study aimed to fill this gap by analyzing the clinical outcomes, revision rates, and complications following pediatric VP shunt procedures at Misrata Medical Center over a three-year period.

II) Materials and methods:

A retrospective chart review was conducted for all pediatric patients (age <14 years) who underwent VP shunt surgery at the Misrata Medical Center between January 2021 and December 2025. This study was approved by the Institutional Ethics Committee of Misrata Medical Center.

A) Data Collection

The collected data included demographic information (age at surgery and sex), clinical information (indication for shunting and presence of comorbidities), surgical details (shunt and valve type such as Medtronic or Integra, and surgical approach whether frontal or occipital), and outcomes including the number and timing of revisions, causes of revision, mortality, and involvement of multidisciplinary teams**.**

B) Data Analysis

Data were analysed using SPSS version 26. Descriptive statistics were calculated for all variables. Comparative statistics, including the Chi-square test or Fisher's exact test, were used to explore associations between variables and outcomes.

C) Study Population

A total of 144 patients were included in the study. The majority were male (102, 70.8%), with 42 females (29.2%). Infants under one year of age accounted for 44 patients (30.6%). Comorbidities were present in 68 patients (47.2%), and 120 patients (83.3%) received care from a multidisciplinary team.

D) Patient Demographics

A total of 144 patients were included. Males represented 102 patients (70.8%), while females accounted for 42 patients (29.2%). Infants younger than one year constituted 44 cases (30.6%), and the remaining 100 patients (69.4%) were one year or older.

Variable	Frequency (N=144)	Percentage
Gender		
Male	102	70.8%
Female	42	29.2%
Age Group		
< 1 year	44	30.6%
≥ 1 year	100	69.4%

Table 1: Patient Demographics

E) Indications for Shunting

The leading indication for shunt insertion was congenital hydrocephalus, affecting 69 patients (47.9%), followed by postinfectious hydrocephalus in 46 patients (31.9%). Aqueductal stenosis formed the predominant congenital cause. Among infants under one year of age, post-meningitis hydrocephalus was the most common etiology. In contrast, older children more frequently presented with space-occupying lesions.

Etiology	< 1 year (N=44)	≥ 1 year (N=100)	Total (N=144)
Congenital (Aqueductal Stenosis, Chiari)	21	6	27 (18.8%)
Myelomeningocele/Spinal Dysraphism	15		15 (10.4%)
Post-Infectious (Meningitis)	40	6	46 (31.9%)
Space-Occupying Lesion		26	26 (18. %)
Post-Traumatic	3		3 (2.1%)
Other Congenital	8		8 (5.6%)
Other Acquired		56	56 (38.9%)

Table 2: Etiology of Hydrocephalus by Age Group

F) Surgical Characteristics

Most procedures were ventriculoperitoneal (VP) shunt insertions (140 patients, 97.2%), while ventriculoarterial (VA) shunts were used in only four cases (2.8%). Medtronic valves were utilized in 116 patients (80.6%). The frontal surgical approach was the preferred technique and was performed in 121 patients (84%).

G) Shunt Revision Outcomes

Out of the 144 patients, 49 (34%) underwent at least one shunt revision. In most of these cases (31 patients, 63.3%), the first revision occurred within six months of the initial surgery. The leading causes of the first revision were shunt obstruction (24 patients, 49%) and shunt infection (17 patients, 34.7%).

Across these 49 patients, a total of 234 revision procedures were recorded. Infection was the most frequent cause of all revision events (88 cases, 37.6%), followed by CSF leakage (19.2%) and skin perforation or erosion (17.1%). Both proximal and distal obstructions together accounted for approximately 12% of all revision events.

Cause	N	% of Total Events
Infection	88	37.6%
CSF leak	45	19.2%
Skin perforation / erosion	40	17.1%
Proximal obstruction	15	6.4%
Distal obstruction	13	5.6%
Abdominal CSF collection	7	3.%
Ascites	6	2.6%
Migration	4	1.7%
Overdrainage	3	1.3%

Valve disconnection	3	1.3%
Fracture	2	.9%
Nephritis	2	.9%

Table 3: Distribution of All Revision Events (N=234) in 49 Patients

III) Mortality and Survival

The overall mortality rate was 11.8% (17 patients died). Mortality was significantly higher in infants (17%) than in older children (6%). Patients who underwent multiple revisions also experienced higher mortality rates. The 5-year survival rate was lowest in the post-hemorrhagic and congenital hydrocephalus groups (p=.3).

This study provides a comprehensive overview of the outcomes of pediatric VP shunt surgery at a major medical center in Libya. Our findings confirm that although VP shunting is lifesaving, it is associated with a high burden of complications, with a 34% revision rate in our cohort. This rate is comparable to some international reports but is higher than those from highly specialized centers in Europe, which report rates below 8%.

The primary drivers of shunt failure in our study were obstruction (49%) and infection (34.7%). The predominance of obstruction aligns with the global literature, where it is often cited as the most common cause of mechanical failure, frequently due to occlusion by the choroid plexus or cellular debris. The infection rate in our study is a point of concern. While shunt infections are a known risk, particularly within the first six months post-implantation, our rate appears elevated compared to the benchmarks of 5-15% in many centers. This highlights a critical area for improvement, potentially through stricter adherence to sterile protocols, the use of antibiotic-impregnated catheters, and standardized surgical techniques.

A key finding is the vulnerability of infants under one year of age.[4] This group not only constituted a significant portion of our patients (30.6%) but also experienced higher rates of revision and mortality. This is consistent with other studies that identified young age as a major risk factor for shunt failure, likely due to smaller ventricle size, a more robust inflammatory response, and rapid growth [5]. Congenital etiologies like aqueductal stenosis and myelomeningocele were dominant in this age group, reinforcing the link between underlying pathology and outcome.[6]

In our series, the frontal approach and Medtronic valves were the most used. While our study did not have the statistical power to detect significant outcome differences between valve types or surgical approaches, this reflects the prevailing practice at our institution.[7]

The management of shunt infections at our centre involves shunt externalization, CSF drainage, targeted intravenous antibiotics, and reimplantation after CSF sterilization [8]. This multi-step process, while standard, contributes to prolonged hospital stays and increased psychological and financial burden on patients and their families.[9]

IV) Clinical Implications

Infants represent a high-risk group and require intensive postoperative monitoring to detect early signs of shunt malfunction.[11] Infection remains a significant concern; therefore, reviewing institutional sterile protocols and considering the use of antibiotic-impregnated catheters may help reduce infection rates. [10] For congenital obstructive hydrocephalus, such as aqueductal stenosis, endoscopic third ventriculostomy (ETV) should be considered as a primary treatment option to minimize long-term hardware-related complications. [12]

V) Limitations

This study is limited by its retrospective design, which introduces the potential for selection bias and incomplete data. As a single-center study, its findings may not be generalizable to other populations or settings. A prospective, multicenter study would be beneficial to validate these findings and further investigate the risk factors for shunt failure.

VP shunt surgery for pediatric hydrocephalus at our center carries a significant risk of failure, primarily due to obstruction and infection. Infants under one year of age represent a particularly high-risk population. These findings highlight the urgent need for targeted strategies aimed at preventing complications, including rigorous infection control protocols and careful patient selection for alternative procedures, such as ETV. Continuous quality improvement and further research are essential to reduce revision rates and improve long-term outcomes in these vulnerable patients.

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