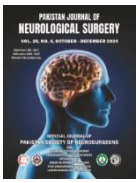

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Original Research

Patterns and Rates of Early Complications in Endoscopic Third Ventriculostomy for Obstructive Hydrocephalus

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ABSTRACT

Objective: To evaluate the frequency and pattern of early complications of endoscopic third ventriculostomy in patients with obstructive hydrocephalus.

Materials and Methods: This descriptive case series was conducted at the Department of Neurosurgery, MTI/Lady Reading Hospital, Peshawar, involving patients diagnosed with obstructive hydrocephalus who underwent third endoscopic ventriculostomy under general anesthesia, followed by a seven-day monitoring period for complications such as wound infection, CSF leak, seizures, and meningitis.

Results: A total of 127 patients were enrolled. The patients' ages varied from 6 months to sixty years. The mean age of the patients was 36.41 ± 9.36 years. Male to female ratio was 2.4:1. Overall complications were observed in 20 patients (15.7%). The most common complication was a CSF leak observed in 07 patients (5.5%), followed by wound infection in 05 patients (3.9%), meningitis and seizures were reported in 4 patients (3.1%) each.

Conclusion: In terms of complications, endoscopic third ventriculostomy is a safe procedure with a lower complication rate. The CSF leak was the most common reported complication.

Keywords: Obstructive Hydrocephalus, Endoscopic Third Ventriculostomy, Complications.

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INTRODUCTION

For more than 50 years, the ventriculo-artrial and ventriculoperitoneal shunts, a unidirectional valve system linked to biocompatible silicon catheters—served as the primary therapeutic alternatives for the treatment of all forms of hydrocephalus.[1] The invention of autoregulating, antisiphon, externally adjustable, and gravitational valves was made possible by advancements in valve technology. These methods help reduce the possibility of

hydraulic errors resulting in either over-drainage or under-drainage, but the main issues related to shunt implantation—shunt infection and malfunction—remain.[2,3]

The neurosurgeons looked for other methods of managing obstructive hydrocephalus because of these two problems. One such potential substitute for shunt implantation was inner shunting, which involved puncturing the third ventricle's floor and establishing communication with the basal cisterns.[4] In 1922, Walter Dandy employed a ventriculostomy to examine the ventricles through a subfrontal method. He later refined this technique to use a lateral subtemporal route.[5] Mixter made the stoma in the third ventricle floor using the transventricular method for the first time using an endoscope. With advancements to the instruments, particularly the working channels inside the endoscopic sheath, ETV has completely changed the way that obstructive hydrocephalus is treated. Additionally, improvements to the quality of the optics have a significant impact on this.[6] By creating a stoma in the third ventricle's floor and connecting it to the basal cisterns, ETV is a safe and effective treatment for obstructive hydrocephalus. This allows the CSF to flow freely. Ventriculostomy was referred to by McNickle in 1947 as "an attempt to bypass obstruction."[7]

According to the literature, ETV has a complication rate of 5 to 15%, with relatively few long-term, severely incapacitating problems.[8,9] In a study by Ullah A and colleagues, the frequency of CSF leak after endoscopic third ventriculostomy was 5% followed by wound infection in 2% of patients, hemorrhage in 1% while meningitis and seizures were observed in 2 patients each.[10]

Complications related to endoscopic third ventriculostomy for obstructive hydrocephalous are not uncommon. However, knowledge is scarce regarding these complications in our local population. Therefore, our goal was to ascertain, in our community, the incidence and pattern of early problems associated with endoscopic third ventriculostomy for obstructive hydrocephalus. Future researchers on this subject can make use of the study's findings.

MATERIALS AND METHODS

Study Design & Setting

A descriptive case series was conducted at the Department of Neurosurgery, MTI/Lady Reading Hospital in Peshawar, from 1st Jan 2022 to 31st December 2023. Using the WHO sample size formula, a total of 127 participants were included, based on an anticipated CSF leak frequency of 3.5%, a 12% margin of error, and a 95% confidence level. Non-probability consecutive sampling was used.

Inclusion Criteria

The study included patients aged 6 months to 60 years, of both genders, who present with obstructive hydrocephalus as defined by the operational criteria.

Exclusion Criteria

The study excluded patients with lesions near the basilar artery or the floor of the third ventricle, as well as those exhibiting slit ventricles on CT imaging.

Data Collection

Following permission from the research review board (Ref: No 753/LRH/MTI) patients who fulfilled the inclusion criteria were sourced from the hospital's indoor department. Consent was obtained in a way that guaranteed anonymity, and the absence of risk associated with participating in the study. Age, gender, BMI, and length of illness were recorded as baseline data. Complete medical history and detailed examination were performed as per protocol. Evaluation by a consultant cardiologist, pulmonologist, and anesthesiologist was performed as per protocol before surgery. After complete evaluation, patients fit for surgery

would proceed to endoscopic third ventriculostomy under general anesthesia by a consultant neurosurgeon with a minimum of 05 years post-fellowship experience. After surgery, the patient was monitored for the next seven days for the development of any complications. The presence of complications was noted as per operational definitions. Data was recorded by the researcher himself on specially designed proforma.

Data Analysis

IBM SPSS version 24 was used for statistical analysis of the data. Qualitative variables such as gender and post-operative complications were computed as frequencies and percentages. For quantitative characteristics such as age, BMI, and length of illness, the mean and standard deviation were calculated. Outcome variables (early complications including wound infection, CSF leak, meningitis, and seizure) were stratified by age, gender, BMI, and disease duration. At a significance level of 5%, the post-stratification chi-square test was used. P-values less than 0.05 were considered significant in statistics.

RESULTS

Demographics & Baseline Characteristics

In this study, the patients were between the ages of 6 months and 60 years. The mean age was 36.41 ± 9.36 years, the mean weight was 67.54 ± 12.34 kg, the mean height was 171.4 ± 9.27 cm, mean BMI was 21.7 ± 4.087 kg/m^2, At the time of presentation, the mean duration of complaints was 6.89 ± 1.006 months as shown in Table 1.

Table 1: Mean ± SD of patients according to age, weight, height, BMI, and Disease Duration (days) N = 127.

Demographics & Baseline Characteristics	Mean ± Standard Deviation
Age (years)	36.41 ± 9.36
Weight (kg)	67.54 ± 12.34
BMI (kg/m^2)	21.78 ± 4.087
Disease Duration (months)	6.89 ± 1.006

Age Distribution

Among 127 patients, the majority, 70 (55.0%), were aged ≤30 years, while 57 (45.0%) were aged >30 years.

Gender Distribution

There were 90 (71.0%) male and 37 (29.0%) female patients.

Duration of Disease

Table 2 presents the distribution of patients based on disease duration. Out of 127 patients, 43 (34.0%) had a disease duration of ≤3 months, while 84 (66.0%) had a duration of >3 months, representing the total sample.

Table 2: Frequency and %age of patients according to disease duration N127.

Disease duration (months)	Frequency	Percent
≤3	43	34.0
>3	84	66.0
Total	127	100.0

Frequency of Complications

Table 3 shows the frequency of complications among 127 patients. Twenty patients (15.7%) experienced complications, while 107 patients (84.3%) did not.

Table 3: Frequency and %age of patients according to complications N = 127.

Complications	Frequency	Percent
Yes	20	15.7
No	107	84.3
Total	127	100.0

Pattern of Complications

The incidence and percentage of individuals who

had different problems are shown in Table 4. A CSF leak, which affected 35% of patients, was the most frequent consequence. 25% of patients had wound infections, 20% of patients had meningitis and 20% had seizures.

Table 4: Frequency and percentage of patients according to pattern of complications.

Pattern of Complications	Frequency	Percent
CSF Leak	7	35.0
Wound Infection	5	25.0
Meningitis	4	20.0
Seizures	4	20.0
Total	20	100.0

Stratification of CSF Leak Concerning Gender

Table 5 categorized 127 individuals' CSF leaks by gender. Results indicated that 5.4% of females (2 out of 37) and 5.5% of males (5 out of 90) had CSF leaks. 120 patients (94.5%) did not have CSF leaks, compared to 7 individuals (5.5%) who did. The genders did not significantly differ in the frequency of CSF leaks, as indicated by the p-value of 0.899.

Table 5: Stratification of CSF leak concerning Gender N = 127.

		CSF Leak		Total	
		Yes	No		
Gender	**Male**	05(5.5%)	85(94.5%)	90	**p-value = 0.899**
	Female	02(5.4%)	35(94.6%)	37	
Total		07(5.5%)	120(94.5%)	127	

Stratification of CSF Leak Concerning Age

Table 6 categorized the 127 patients' CSF leaks according to age. It showed that 4. out of 70 patients, or 5.7% of those under 30, had CSF leaks, whereas 3. out of 57 patients, or 5.3% of those over 30, did. Out of all the patients, 120 (94.5%) did not experience CSF leaks, while 7 individuals (5.5%) did. The age-related variation in CSF leak occurrence was not statistically significant, as indicated by the p-value of 0.912.

Table 6: Stratification of CSF Leak Concerning Age.

		CSF Leak		Total	p-value
		Yes	No		
Age (years)	**≤30**	4(5.7%)	66(94.3%)	70	**0.912**
	>30	3(5.3%)	54(94.7%)	57	
Total		07(5.5%)	120(94.5%)	127	

Stratification of CSF Leak Concerning Disease Duration

CSF leaks among 127 patients were categorized by disease duration in Table 7. The data indicated that CSF leaks occurred in 4.6% of patients (2 out of 43) with a disease duration of three months or less and in 5.9% of patients (5 out of 84) with a disease duration of more than three months. Out of all the patients, 120 (94.5%) did not have CSF leaks, while 7 patients (5.5%) did. The CSF leak rate was not significantly affected by the length of the disease, as indicated by the p-value of 0.790.

Table 7: Stratification of CSF leak concerning disease duration.

Disease Duration (months)	CSF Leak (Yes)	CSF Leak (No)	Total
≤3	2(4.6%)	41(95.4%)	**43**
>3	5(5.9%)	79(94.1%)	**84**
Total	7(5.5%)	120(94.5%)	**127**
p-value			**0.790**

Stratification of Wound Infection Concerning Age

According to Table 8, which stratified wound infection by age, 4.3% of people under 30 and 3.5% of those over 30 had wound infections, respectively. This suggests that there is no discernible difference in the incidence of infection between the two age groups (p = 0.859).

Stratification of Wound Infection Concerning Gender

Table 9 demonstrates that, out of 127 cases, 5 patients (3.9%) had wound infections; 4 males

(4.4%) and 1 female (2.7%) were infected, with a p-value of 0.371 suggesting no significant gender correlation.

Table 8: Stratification of Wound Infection concerning AGE.

Age (Years)	Wound Infection (Yes)	Wound Infection (No)	Total
≤30	3 (4.3%)	67 (95.7%)	**70**
>30	2 (3.5%)	55 (96.5%)	**57**
Total	5 (3.9%)	122 (96.1%)	**127**
p-value			**0.859**

Table 9: Stratification of Wound Infection Concerning Gender.

		Wound Infection Yes	Wound Infection No	Total	
Gender	Male	4(4.4%)	86(95.6%)	90	**p-value = 0.371**
	Female	1(2.7%)	36(97.3%)	37	
Total		**5(3.9%)**	**122(96.1%)**	**127**	

Stratification of Wound Infection Concerning Disease Duration

Based on the stratification of wound infection by disease duration, Table 10 reveals that, out of 127 instances, 2 infections (4.6%) were identified among 43 cases with a disease duration of three months or less, and 3 infections (3.6%) were found among 84 cases with a duration higher than three months. This causes a total of 5 infections (3.9%). The p-value of 0.640 indicates that the rates of wound infection and the length of the disease are not significantly correlated.

Stratification of Meningitis Concerning Age

Table 11 illustrates that, out of 127 instances, the age-stratification of meningitis found that 2 cases (2.8%) occurred in people under 30 years old, and 2 cases (3.5%) occurred in people over 30. Meningitis was reported in 4 patients overall (3.1%). There was no significant correlation between meningitis rates and age, as evidenced by the p-value of 0.793.

Table 10: Stratification of Wound Infection Concerning Disease Duration N = 127.

		Wound Infection Yes	Wound Infection No	Total	
Disease Duration (months)	**≤3**	2(4.6%)	41(95.4%)	43	**p-value = 0.640**
	>3	3(3.6%)	81(96.4%)	84	
Total		**5(3.9%)**	**122(96.1%)**	**127**	

Table 11: Stratification of Meningitis Concerning Age.

		Meningitis Yes	Meningitis No	Total	
Age (Years)	**≤30**	2(2.8%)	68(97.2%)	70	**p-value = 0.793**
	>30	2(3.5%)	55(96.5%)	57	
Total		4(3.1%)	123(96.9%)	127	

Stratification of Meningitis Concerning Gender

Table 12 illustrates that, out of 127 cases, the gender-based stratification of meningitis cases showed that 3 cases (3.3%) involved males and 1 case (2.7%) involved females. Meningitis was reported in 4 patients overall (3.1%). There was no significant correlation between meningitis rates and gender, as evidenced by the p-value of 0.771.

Table 12: Stratification of Meningitis Concerning Gender.

		Meningitis Yes	Meningitis No	Total	
Gender	**Male**	3(3.3%)	87(96.7%)	90	**p-value = 0.771**
	Female	1(2.7%)	36(97.3%)	37	
Total		4(3.1%)	123(96.9%)	127	

Stratification of Meningitis Concerning Disease Duration

Table 13 illustrates that, out of 127 instances, 3 cases (3.6%) of meningitis were found among patients whose disease duration was more than

three months, and 1 case (2.3%) among those whose disease duration was less than three months. There were 4 incidences of meningitis overall (3.1%). The absence of a significant correlation between the length of the condition and the incidence of meningitis was revealed by the p-value of 0.640.

Table 13: Stratification of meningitis concerning Disease Duration.

		Meningitis		Total	
		Yes	No		
Disease Duration (months)	**≤3**	1(2.3%)	42(97.7%)	43	**p-value = 0.640**
	>3	3(3.6%)	81(96.4%)	84	
Total		4(3.1%)	123(96.9%)	127	

Stratification of Seizure Concerning Age

Table 14 demonstrates that out of 127 cases, 4 (3.1%) had seizures; 2 (2.8%) involved people 30 years of age or less, and 2 (3.5%) involved people over 30. 123 people (96.9%) reported they did not have any seizures. Age and seizure rates did not significantly correlate, as evidenced by the p-value of 0.793.

Table 14: Stratification of Seizure Concerning Age.

		Seizure		Total	
		Yes	No		
Age (Years)	**≤30**	2(2.8%)	68(97.2%)	70	**p-value = 0.793**
	>30	2(3.5%)	55(96.5%)	57	
Total		4(3.1%)	123(96.9%)	127	

Stratification of Seizure Concerning Gender

Table 15 reveals that out of 127 cases, 4 (3.1%) had seizures, with 3 (3.3%) involving men and 1 (2.7%) involving women. There were 123 (96.9%) people who did not have any seizures at all. There was no discernible relationship between gender and seizure frequencies, as the p-value of 0.771 showed.

Table 15: Stratification of Seizure Concerning Gender.

		Seizure		Total	
		Yes	No		
Gender	**Male**	3(3.3%)	87(96.7%)	90	**p-value = 0.771**
	Female	1(2.7%)	36(97.3%)	37	
Total		4(3.1%)	123(96.9%)	127	

Stratification of Seizure Concerning Disease Duration

Table 16 reveals that out of 127 cases, 4 (3.1%) had seizures; 1 case (2.3%) involved people whose sickness had been ongoing for three months or less, and 3 cases (3.6%) involved people whose disease had been ongoing for more than three months. There were 123 (96.9%) people who did not have any seizures at all. The time of the disease and the frequency of seizures did not significantly correlate, as evidenced by the p-value of 0.640.

Table 16: Stratification of Seizure concerning Disease Duration.

		Seizure		Total	
		Yes	No		
Disease Duration (Months)	**≤3**	1(2.3%)	42(97.7%)	43	**p-value = 0.640**
	>3	3(3.6%)	81(96.4%)	84	
Total		4(3.1%)	123(96.9%)	127	

DISCUSSION

Ventricular dilatation is decreased in patients with hydrocephalus via CSF diversion. Even while improvements in cognitive and neurological functioning are frequently observed, the results vary greatly. There are several publications in the literature that link different clinical and radiographic factors to the result of hydrocephalus.

The prevalence of hydrocephalus is one to two percent. Treatment included either extracranial or intracranial diversion as part of the usual protocol.[11] While shunt technology has advanced significantly in recent years, hydrocephalus

remains a challenging condition to treat, which has neurosurgeons searching for alternative solutions. CSF shunts are frequently used to treat hydrocephalus. Research indicates that individuals undergoing CSF shunting experience problems related to overflow, blockage, and disconnection in their drainage systems, as well as infection.[12] The emphasis in hydrocephalus therapy is moving from shunts to endoscopic methods.[13] Quick access is made possible by tiny burr holes that don't require brain retraction. For hydrocephalus, there is no known treatment.[14] The ventriculostomy is frequently created with endoscopes and other blunt tools, such as guide wires, Bugbee wires, laser fibers, closed-jaw forceps, and dormia baskets. Two of the most common adverse effects are fever and bleeding.[15] Short-term memory loss is possible due to the treatment's potential effects on the hypothalamus and other memory-related components of the mamillary body.

In 20 patients (15.5%), we discovered problems. In 07 (5.5%) cases, the most frequent finding was a CSF leak.[16] Compared to the 2–15% complication rate found in the literature, some studies have shown a 30% complication rate with ETV. Our study's complication rate is consistent with the literature.[17] Reports of CSF leakage following ETV for obstructive hydrocephalus have been made for 1.8%, 5.16 percent, and 10.2 percent.[10] The current study indicated that 3 (2.6%) patients had bleeding, 4 (3.5%) cases had seizures, and 1 case had meningitis. 2 (1.7%) cases resulted in mortality. Based on the research, there is a 0.22 percent to 17.5% variation in the death rate following ETV.[18,19] Individuals with preoperative third ventricular bowing had a threefold higher likelihood of success with ETV than those without this bowing. Even while bowing is a predictor, 33% of patients who did not bow responded well to ETV treatment. It is challenging to identify which type of hydrocephalus is more common since patients frequently have both communicative and intraventricular obstructive components. In cases where a patient's third ventricular floor deforms, or "bows," indicating intraventricular obstructive hydrocephalus, endoscopic third ventriculostomy has a better success rate, according to earlier studies (ETV).[20] Endoscopic results showed three patterns: beneath the third ventricle's floor, a patent ventriculostoma with newly formed arachnoid membranes, ventriculostoma reclosure, and ventriculostoma narrowing. At the time of the first ETV, these findings were not known.[21] All patients had novel CSF pathways discovered to be occluded after ETV or shunt surgery. An endoscopic third ventriculostomy may be used as first-line treatment for obstructive hydrocephalus. Due to the minimal harm it causes to the body, many choose it over alternative treatments. The drawbacks of shunt implantation are likewise circumvented by ETV. There are several situations in which we think ETV can be a secure and useful therapy.

A reduction in ventricular dilatation and an expansion in cortical mantle thickness are the results of CSF diversion. According to Rubin et al's findings, reactive Astrocytosis and a reduction in white matter edema are the causes of the rebuilding of the cortical mantle.[22] According to his theory, neurological recovery is only partially reversible, and clinical improvement is caused by the functional enhancement of the surviving neural elements rather than the replacement of lost elements. According to this study, both categories saw statistically significant (P value less than 0.01) reconstruction of the cortical mantle after shunt surgery.

CONCLUSION

The goal of hydrocephalus care is to attain normal or nearly normal intellectual development as well as complete clinical recovery. However, it appears that several things influence the result. For patients with obstructive hydrocephalus, endoscopic third ventriculostomy is a safe and successful procedure that has a minimal risk of complications and a decreased death rate.

RECOMMENDATIONS

Develop and implement standardized perioperative protocols to minimize complications associated with endoscopic third ventriculostomy (ETV).

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Additional Information:

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Data Availability: The data supporting this study's findings are available from the corresponding author upon reasonable request.
Ethical Review Board Approval: The study conformed to the ethical review board requirements. Approval was taken from the ethical board of the hospital. (Ref: No 753/LRH/MTI).
Human Subjects: Consent was obtained by all patients/participants in this study.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Authors Full Name	Intellectual Contribution to Paper in Terms of:
Irshad khan & Amer Zaman	Study design and methodology
Amer Zaman & Bilal Ahmad	Analyzing the data and interpretation of results
Irshad Khan & Waseef Ullah	Data collection, paper writing, and calculation
Nafees Ahmad Khan	Data collection and calculation
Ibrahim & Waseef Ullah	Quality insurer and literature review
Ibrahim & Amer Zaman	Editing, referencing, and final approval