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ORIGINAL ARTICLE

Assessing Early Complications and Surgical Outcomes of Endoscopic Third Ventriculostomy in Obstructive Hydrocephalus: Insights from 128 Cases

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ABSTRACT

Background: Endoscopic Third Ventriculostomy (ETV) is a well-established treatment for obstructive hydrocephalus, particularly in cases where other interventions, such as shunting, are not ideal. Despite its benefits, early complications remain a concern. This study aims to investigate the frequency and pattern of early complications following ETV in 128 patients with obstructive hydrocephalus.

Methods: A retrospective analysis was conducted on 128 patients who underwent ETV for obstructive hydrocephalus at a tertiary care institution between 2015 and 2020. Patient demographics, surgical outcomes, and early postoperative complications (within 30 days of surgery) were assessed. The complications evaluated included infection, bleeding, cerebrospinal fluid (CSF) leakage, stoma obstruction, and neurological deterioration.

Results: The overall complication rate was 18.75%. The most common complications were infection (5.5%), CSF leakage (4.5%), and stoma obstruction (4.0%). Infection was primarily characterized by wound infections and ventriculitis. Stoma obstruction was observed in 5 cases, requiring re-operation. Postoperative deterioration of neurological status occurred in 3.9% of patients, while seizures were observed in 2.3% of cases.

Conclusion: ETV is a generally safe and effective procedure for treating obstructive hydrocephalus, with a manageable complication rate. Early complications primarily include infection, CSF leakage, and stoma obstruction. Timely detection and appropriate management of these complications can significantly improve postoperative outcomes.

Keywords: Endoscopic Third Ventriculostomy, obstructive hydrocephalus, early complications, stoma obstruction, CSF leakage, infection.

INTRODUCTION

Obstructive hydrocephalus, characterized by the blockage of cerebrospinal fluid (CSF) circulation, is a critical condition that can lead to neurological decline and requires surgical intervention for effective management. Traditionally, CSF diversion via ventriculoperitoneal shunting has been the standard treatment for hydrocephalus. However, Endoscopic Third Ventriculostomy (ETV) has emerged as a favorable alternative, particularly in patients with aqueductal stenosis or other obstructive pathologies that do not respond well to shunting[1]. ETV involves the creation of a fenestration in the floor of the third ventricle, which restores normal CSF flow and reduces ventricular dilation[2].

Although ETV offers promising outcomes with fewer long-term complications compared to shunt placement, early postoperative complications remain a significant concern[3]. These complications may include infection, bleeding, CSF leakage, stoma obstruction, and postoperative neurological deterioration (4). In this study, we focus on the early complications (within 30 days) observed in a cohort of 128 patients undergoing ETV for obstructive hydrocephalus.

Despite its increasing adoption, comprehensive data regarding the frequency, risk factors, and management of these early complications are still limited. A better understanding of these issues could improve patient care and surgical outcomes. The primary objective of this study is to evaluate the frequency and nature of early complications after ETV in patients with obstructive hydrocephalus and to discuss the factors contributing to these outcomes.

METHODOLOGY

This was a retrospective cohort study conducted at Department of Neurosurgery Punjab Institute of Neurosciences Lahore from October 2022 to September 2023, which included 128 consecutive patients who underwent ETV for obstructive hydrocephalus from January 2015 to December 2020. All patients were diagnosed with obstructive hydrocephalus based on clinical symptoms, imaging findings (such as MRI or CT scans), and cerebrospinal fluid analysis.

Inclusion Criteria:

- Adults and children aged 18 and above.
- Confirmed obstructive hydrocephalus, primarily due to aqueductal stenosis, tumors, or post-hemorrhagic hydrocephalus.
- Patients who underwent ETV as the primary treatment modality.

Exclusion Criteria:

- Patients with shunted hydrocephalus.
- Patients who underwent other forms of surgery for hydrocephalus (e.g., ventriculoperitoneal shunting).
- Patients with incomplete follow-up data.

Data Collection: Patient demographics, clinical presentations, intraoperative details, and postoperative outcomes were extracted from electronic medical records. Early complications (within 30 days post-surgery) were classified as:

- **Infection**: Wound infection, meningitis, or ventriculitis.
- **Bleeding**: Subdural hematoma, intraventricular hemorrhage.
- **CSF leakage**: Postoperative CSF leaks resulting in pseudomeningocele or fistulas.
- **Stoma obstruction**: Recurrent symptoms of hydrocephalus due to obstruction of the third ventriculostomy stoma.
- **Neurological deterioration**: Worsening of neurological function, including seizures or cognitive decline.

Statistical Analysis: Descriptive statistics were used to summarize the demographic characteristics of the patient population and the frequency of complications. Chi-square or Fisher's exact tests were used to determine associations between

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categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographic details of the 128 patients included in the study. It includes the total number of patients, gender distribution, and the mean age of the cohort. The table also categorizes the etiologies of obstructive hydrocephalus, which were the primary indications for the Endoscopic Third Ventriculostomy (ETV) procedure. The majority of patients (79.7%) had hydrocephalus due to aqueductal stenosis, while the rest had hydrocephalus due to tumors (11.7%) or hemorrhagic events (8.6%). (Table 1)

Table 1: Demographic Characteristics of Study Participants

Characteristic	Value
Total number of patients	128
Male (n, %)	66 (51.6%)
Female (n, %)	62 (48.4%)
Mean age (range)	43 years (19–76)
Etiology of Hydrocephalus	
Aqueductal stenosis (n, %)	102 (79.7%)
Tumor-related (n, %)	15 (11.7%)
Post-hemorrhagic (n, %)	11 (8.6%)

Frequency and distribution of early postoperative complications observed within 30 days after the ETV procedure. The overall complication rate was 18.75%, with the most common complications being infection (5.5%), cerebrospinal fluid (CSF) leakage (4.5%), and stoma obstruction (4.0%). Infection-related complications included wound infection and ventriculitis, while CSF leakage led to the formation of pseudomeningoceles and CSF fistulas. Five patients required reoperation due to stoma obstruction. Other complications included neurological deterioration (3.9%), seizures (2.3%), and bleeding (1.5%). (Table 2)

Table 2: Frequency of Postoperative Complications

Complication	Frequency (n, %)
Total complications	24 (18.75%)
Infection	7 (5.5%)
Wound infection	4 (3.1%)
Ventriculitis	3 (2.3%)
CSF leakage	6 (4.5%)
Pseudomeningocele	4 (3.1%)
CSF fistula	2 (1.5%)
Stoma obstruction	5 (4.0%)
Neurological deterioration	5 (3.9%)
Seizures	3 (2.3%)
Cognitive decline	2 (1.5%)
Bleeding	2 (1.5%)
Subdural hematoma	2 (1.5%)

Postoperative symptoms experienced by patients after ETV, along with their resolution time. Symptoms such as headache (68%), nausea (50%), and vomiting (45%) were the most frequently reported in the early postoperative period. All of these symptoms resolved within 72 hours post-surgery. Other symptoms like fever (12%) and drowsiness (14%) were also observed but resolved within the same timeframe in the majority of patients. (Table 3)

Table 3: Postoperative Symptoms and Resolution

Symptom	Frequency (n, %)	Resolution (n, %)
Headache	87 (68%)	100% (within 72 hours)
Nausea	64 (50%)	100% (within 72 hours)
Vomiting	58 (45%)	100% (within 72 hours)
Fever	15 (12%)	80% (within 72 hours)
Drowsiness	18 (14%)	90% (within 72 hours)

A detailed account of the five patients who experienced stoma obstruction and required reoperation. It includes the reoperation type, which typically involved re-exploration or revision of the stoma, and the outcomes of these procedures. All five patients who underwent reoperation had successful results, and their hydrocephalus symptoms were resolved postoperatively. This emphasizes the importance of prompt intervention in cases of stoma obstruction to ensure optimal outcomes. (Table 4)

Table 4: Reoperation Details for Stoma Obstruction

Reoperation Case (n = 5)	Details
Patient 1	Stoma obstruction, re-exploration, successful
Patient 2	Stoma obstruction, re-exploration, successful
Patient 3	Stoma obstruction, stoma revision, successful
Patient 4	Stoma obstruction, stoma revision, successful
Patient 5	Stoma obstruction, stoma revision, successful

Five patients who experienced neurological deterioration within 30 days post-surgery, including three cases of seizures and two cases of cognitive decline. The outcomes of these patients are also included, showing that seizures were effectively controlled with anticonvulsant treatment, and cognitive function improved in the patients with cognitive decline within a week of treatment. (Table 5)

Table 5: Outcome of Neurological Deterioration and Seizures

Case	Outcome
Patient 1 (Seizure)	Seizures resolved with anticonvulsant treatment
Patient 2 (Seizure)	Seizures resolved with anticonvulsant treatment
Patient 3 (Seizure)	Seizures resolved with anticonvulsant treatment
Patient 4 (Cognitive decline)	Cognitive function improved within 1 week post-treatment
Patient 5 (Cognitive decline)	Cognitive function improved within 1 week post-treatment

DISCUSSION

Endoscopic Third Ventriculostomy (ETV) has become a critical treatment modality for obstructive hydrocephalus, especially in cases where shunting may not be ideal due to long-term complications such as shunt malfunction, infection, or the need for repeated revisions. In this study, we sought to investigate the early complications that can arise following ETV, with a focus on their frequency, nature, and clinical management. The overall complication rate of 18.75% observed in our cohort aligns with findings from other studies but highlights that ETV, despite its advantages, is not without risk.

Infection: Infection, occurring in 5.5% of patients, was the most frequent early complication in our study. This is consistent with prior research, where infection rates after ETV range between 3% and 7%[1,2]. The infections in our cohort were primarily wound infections (3.1%) and ventriculitis (2.3%). While infections can occur after any neuro-surgical procedure, the development of ventriculitis is a serious concern because it can complicate the clinical course and potentially lead to further neurological deterioration. Prophylactic antibiotics and careful postoperative care are crucial for preventing infection. Several studies have shown that wound infections are more likely to occur in patients with immunocompromised conditions, poor hygiene, or prolonged surgery times[3,4]. Our findings suggest that proper wound care, early recognition, and antibiotic treatment can reduce the severity and improve outcomes in such cases.

Cerebrospinal Fluid (CSF) Leakage: CSF leakage, found in 4.5% of our patients, is another significant early complication after ETV. Pseudomeningocele and CSF fistulas are the most common manifestations of this issue, and in our study, 6 patients developed CSF leaks postoperatively. Although CSF leakage can be self-limiting in some cases, it may lead to delayed recovery or, in severe cases, require surgical revision[5]. In patients with CSF leakage, it is essential to provide appropriate drainage and monitor for signs of increased intracranial pressure or infection. Most of our patients with CSF leaks responded well to conservative management, and none required reoperation for this complication. This highlights the importance of postoperative monitoring and

early intervention to prevent complications such as wound infections or delayed closure of the dura.

Stoma Obstruction: Stoma obstruction, occurring in 4.0% of patients in our study, was another early complication that required reoperation. This complication, although less frequent, is critical as it directly affects the efficacy of the ETV procedure in resolving hydrocephalus. The obstruction could be caused by factors such as scarring, the formation of granulation tissue, or an inadequate stoma size[6]. Stoma obstruction is one of the most challenging complications in ETV, as it requires prompt reoperation to reopen or revise the stoma to restore proper CSF flow. Other studies have reported stoma obstruction rates of around 3-5%, with some requiring multiple revisions over time[7]. Timely reoperation, as demonstrated in our cohort, can effectively address this issue and prevent further neurological deterioration.

Neurological Deterioration and Seizures: Neurological deterioration, including seizures and cognitive decline, was observed in 3.9% of our patients. This rate is consistent with existing literature, where postoperative seizures are reported in approximately 2-5% of ETV cases[8]. The mechanisms behind postoperative seizures are multifactorial, including surgical trauma, changes in CSF dynamics, and irritation of the brain tissue during the procedure. Seizures are typically controlled with anticonvulsant therapy, as seen in our cohort, where all patients with seizures showed significant improvement with medical management. Additionally, two patients in our study experienced acute cognitive decline, which resolved with conservative management and close observation. Early detection of neurological deterioration and prompt intervention can prevent long-term neurological deficits.

Bleeding Complications: Bleeding complications were relatively rare in our cohort, with subdural hematomas occurring in only 1.5% of patients. In comparison to ventriculoperitoneal shunting, where bleeding complications such as intracerebral hemorrhage can be more common, ETV is associated with a lower incidence of significant bleeding (9). However, it remains essential to monitor for signs of bleeding, especially in the postoperative period, as it may lead to raised intracranial pressure and the need for further intervention. In our study, all patients who developed subdural hematomas were managed conservatively, and no further surgical intervention was required.

Symptom Resolution: The majority of postoperative symptoms, including headache, nausea, and vomiting, resolved within 72 hours, which is consistent with the transient nature of these symptoms following ETV. These symptoms are generally indicative of an initial adjustment phase following surgery, including changes in intracranial pressure and CSF dynamics. Our study shows that most patients recover from these symptoms without the need for additional treatment. This is reassuring for both patients and clinicians, as it suggests that the procedure is generally well-tolerated in the early postoperative period.

Limitations of the Study: While our study provides important insights into the early complications of ETV, it is not without limitations. As a retrospective study, there may be biases in data collection, and some complications may not have been documented or reported. Furthermore, the relatively small sample size and short follow-up period limit the ability to draw definitive conclusions about the long-term outcomes of ETV. Future prospective studies with larger sample sizes and longer follow-up periods are needed to fully understand the long-term success and complications of ETV.

CONCLUSION

ETV offers a safe and effective alternative to shunting for the treatment of obstructive hydrocephalus, early complications remain a concern. Infections, CSF leakage, stoma obstruction, and neurological deterioration are the most common early complications. Despite these challenges, most complications are treatable with prompt intervention, and the overall outcomes for patients are favorable. Careful surgical technique, vigilant postoperative monitoring, and early management of complications are essential to ensure the success of the procedure. With appropriate management, ETV can be a highly effective solution for patients with obstructive hydrocephalus, leading to improved clinical outcomes and reduced long-term dependence on shunting.

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