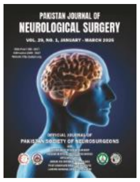

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

One-Year Shunt-Free Survival after Secondary Endoscopic Third Ventriculostomy (ETV) for Shunt Malfunction: Insights from a Tertiary Care Center in a Resource-Constrained Setting

Iqbal Ahmad[1], Shakeel Ahmad Mashoori[2], Muhammad Hasan Raza[3], Muhammad Kashif Chishti[4], Khitamul Haq[5]

[1]Department of Neurosurgery, Nishtar Medical University (NMU), Multan
[2]Department of Neurosurgery, Children's Hospital and Institute of Child Health (CH & ICH), Multan
[3]Department of Neurosurgery, Punjab Institute of Neuro Sciences (PINS), Lahore
[4]Departmentof Surgery, Children's Hospital and Institute of Child Health (CH & ICH), Multan
[5]Department of Neurosurgery, Nishtar Medical University (NMU), Multan – Pakistan

ABSTRACT

Objectives: To assess the one-year shunt-free survival rate in patients undergoing secondary ETV for shunt failure.

Materials & Methods: This retrospective study is done to evaluate the one-year shunt-free outcomes of secondary endoscopic third ventriculostomy (ETV) in 32 patients who presented with ventriculoperitoneal (VP) shunt malfunction due to obstructive hydrocephalus in a tertiary care hospital. Post-operative clinical features of raised intracranial pressure and shunt malfunctions were assessed for one year. MRI or CT scan and a history of shunt revision/insertion during the follow-up period were also noted.

Results: We had 32 patients in our study 17 males (53.1%) and 15 females (46.9%) with shunt malfunction treated by secondary ETV. The mean age at the time of ETV was 12 years with standard deviations ranging from 0.7 to 15 years. The one-year shunt revision-free survival rate was 68.8%. No major complications occurred in patients after the endoscopic procedures.

Conclusion: Results show a significant success rate in achieving shunt-free outcomes, especially in younger patients, favoring, secondary ETV as a viable option as compared to shunt revision.

Keywords: Endoscopy, Hydrocephalus, Ventriculoperitoneal Shunt, shunt failure, Ventriculostomy.

Corresponding Author: Iqbal Ahmad
Department of Neurosurgery, Nishtar Medical University (NMU), Multan
Email: driqbalahmad33@gmail.com

Date of Submission: 15-12-2024

Date of Revision: 25-03-2025
Date of Acceptance: 26-03-2025
Date of Online Publishing: 31-3-2025
Date of Print: 31-3-2025

DOI: 10.36552/pjns.v29i1.1090

INTRODUCTION

Hydrocephalus is a condition in which excessive accumulation of cerebrospinal fluid (CSF) within the ventricles of the brain.[1,2] It is typically treated by insertion of a ventriculoperitoneal (VP) shunt, which delivers excess CSF to the peritoneal cavity.[3] Despite the common use of VP shunts, shunt malfunctions, including mechanical failure, obstruction, and infection, remain a common complication. This type of shunt failure often needs surgical intervention, either in the form of shunt revision or an alternative approach like secondary endoscopic third ventriculostomy (ETV).[4]

However, it should be remembered that the success of primary ETV is accompanied by several factors, such as the patient's age, the etiology of hydrocephalus, and previous history of shunt insertion.[5] For such procedures, the ideal candidates are often over one year old, presented with obstructive hydrocephalus, and without prior shunting experience; in these conditions, the success rate of the procedure lies about 75%.[6] However, in patients who meet none of these criteria, it sits at approximately 50%. However, despite these limitations: ETV has the advantage of maintaining the natural circulation of CSF in the body.[7]

Secondary ETV, which involves creating an opening in the floor of the third ventricle to restore CSF flow, offers a shunt-independent option for patients with obstructive hydrocephalus.[8] While ETV has demonstrated success in primary treatment, its effectiveness as a secondary procedure following VP shunt failure remains less established.[9] This study aims to evaluate the one-year outcomes of secondary ETV in a cohort of patients with obstructive hydrocephalus.

MATERIALS AND METHODS

Study Design and Setting

This retrospective study was conducted at a tertiary care hospital between January 2020 and December 2023. Institutional ethical committee approval was taken through letter no 212. A total of 32 patients who underwent secondary ETV for VP shunt malfunction were included. The sample size was calculated with quantitative analysis. The probability purposive sampling technique was used.

Inclusion Criteria

We included patients who presented with VP shunt malfunction, aged 6 months to 60 years with obstructive hydrocephalus as the etiology of initial VP shunt insertion.

Exclusion Criteria

Patients with infectious or communicating hydrocephalus and unresolved infections at presentation were excluded from the study.

Data Collection

For each patient admitted demographic and prior shunt failure information were taken on admission. All patients underwent preoperative evaluation using the ETV Success Score (ETVSS), criteria that consider patient age, etiology of hydrocephalus, and previous shunting. Patients with shunt malfunction after fulfilling inclusion and exclusion criteria underwent the secondary ETV procedure instead of shunt revision.

Secondary ETV was performed under general anesthesia by experienced consultant neurosurgeons using a rigid endoscope. A stoma was made on the floor of the third ventricle to restore CSF flow, avoiding the need for a VP shunt. Patients were followed for one year postoperatively. Outcomes were defined as successful if no further surgical intervention was required for hydrocephalus and failure if there were clinical and radiological features suggestive of raised intracranial pressure needing shunt insertion/revision.

Data Analysis

Demographic, clinical, and outcome data were recorded and analyzed using SPSS Version 25. Statistical tests, including chi-square, were employed to evaluate the relationships between patient characteristics and surgical outcomes. A P value of less than 0.5 was considered significant.

RESULTS

Gender Distribution

The study consists of 32 patients, with 17 males (53.1%) and 15 females (46.9%) showing a slightly higher male proportion.

Age Distribution

The ages of patients range from 0.5 to 55 years, with a mean age of 11.9 years (SD = 15.01), showing favorable outcomes in younger patients. Most patients (84.4%, 27 cases) had no history of previous shunt failure, while 15.6% (5 cases) reported previous shunt failures (Table 1).

Table 1: *Previous shunt failure.*

Previous Shunt Failure	Gender		Total
	Male	Female	
No	14	13	27
Yes	3	2	5
Total	17	15	32

Etiology of Hydrocephalus in Study Population

The primary etiology among patients is the Aqueduct of Sylvius stenosis, accounting for 65.6% of cases (21 participants). Brain tumor compressing the aqueduct of Sylvius represents 25% of cases (8 patients), and Dandy-Walker Syndrome accounts for 9.4% (3 patients). This highlights the Aqueduct of Sylvius stenosis as the leading cause (Table 2). No statistically significant association was found between gender and etiology (Pearson Chi-Square = 1.906, p = .386).

Table 2: *Etiology of Hydrocephalus in Study Population*

Etiology	Number of Patients (n = 32)	Percentage (%)
Aqueduct of Sylvius stenosis	21	65.6%
Brain tumor compressing the aqueduct of Sylvius"	8	25%
Dandy-Walker Syndrome	3	9.4%

Outcome Analysis

Outcomes were measured as success or failure, with 68.8% of cases (22 patients) achieving success and 31.3% (10 patients) experiencing failure (Table 3). This indicates a favorable overall success rate for the secondary ETV (Figure 1).

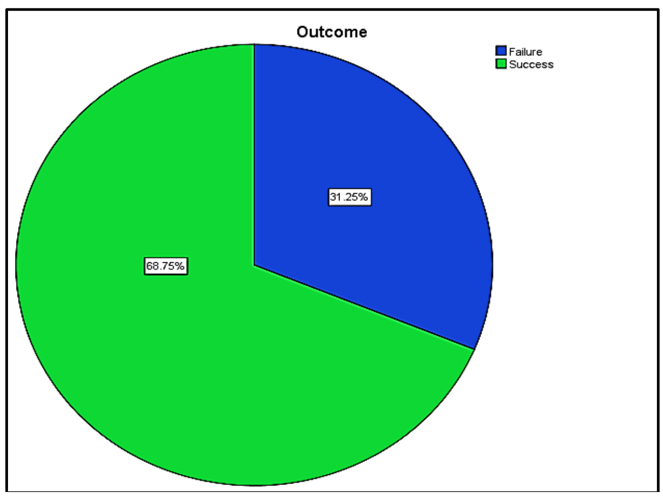

Figure 1: *Outcome Analysis of Secondary ETV at One Year.*

Table 3: *Outcome Analysis of Secondary ETV at One Year*

Outcome	Number of Patients (n = 32)	Percentage (%)
Success (No Shunt Revision)	22	68.8%
Failure (Shunt Revision)	10	31.3%

Pre-op ETV Success Score and Outcome

Patients with a Pre-op ETV Success Score of 80 had the highest success rate (92.9%, 13 out of 14 cases). Those with a score of 70 had a moderate success rate (58.3%, 7 out of 12 cases). Participants with a score of 60 had the lowest success rate (33.3%, 2 out of 6 cases). Table 4 shows the Pre-op ETV Success Score.

Table 4: *Pre-op ETV Success Score.*

Pre-op ETV Success scores	Number of Patients (n = 32)	Success Rate (%)	Successes (n = 22)	Failures (n = 10)
80	14	92.9	13	1
70	12	58.3	7	5
60	6	33.3	2	4

Higher Pre-op ETV Success scores (particularly 80) are strongly associated with successful outcomes, while lower scores (60) are linked to higher failure rates. A higher preoperative ETVSS score correlated with a better chance of achieving a shunt-free outcome (Table 5).

Table 5: *Correlation Between Preoperative ETV Success Score (ETVSS) and Outcome.*

ETVSS Score	Shunt-Free Success (n = 22)	Failure (n = 10)	Total (n = 32)
High (ETVSS ≥ 70)	17 (77.3%)	3 (30%)	20
Low (ETVSS < 70)	5 (22.7%)	7 (70%)	12
Total	22	10	32

p-value< 0.05

COMPLICATIONS

Table 6 presents the complications observed after secondary endoscopic third ventriculostomy (ETV) in a cohort of 32 patients. The majority of patients (81.3%) did not experience any complications following the procedure. However, 9.4% of patients developed cerebrospinal fluid (CSF) leaks, while 6.3% experienced infections. Neurological deficits were noted in 3.1% of patients. These results suggest that after secondary ETV there are very rare complications; including CSF leak, neurological deficit, and infection.

Table 6: *Complications after Secondary ETV.*

Complication	Number of Patients (n = 32)	Percentage (%)
CSF Leak	3	9.4%
Infection	2	6.3%
Neurological Deficits	1	3.1%
No Complications	26	81.3%

DISCUSSION

This study shows after ventriculoperitoneal (VP) shunt abnormal functioning, secondary endoscopic third ventriculostomy (ETV) has a good result showing a 68.8% success rate. These findings are matching with previous studies that evaluate secondary ETV in patients with obstructive hydrocephalus. A study reported a similar success rate of 70% for secondary ETV in a cohort of patients with shunt malfunction due to aqueductal stenosis.[10] Similarly another study demonstrated that secondary ETV could provide long-term, shunt-free outcomes, especially in patients with obstructive hydrocephalus, supporting the procedure need for treatment options for shunt failure.[11]

In this study, we observed that younger patients (6 months to 18 years) had higher success rates, which was statistically significant ($p < 0.05$). This result is in agreement with findings from a study that reported that younger patients generally experience better outcomes after ETV, likely due to the greater brain compliance and increased flexibility seen in younger individuals.[12] Another study also suggested that the elasticity of brain tissue in children may facilitate the formation of a functional stoma, which improves cerebrospinal fluid (CSF) circulation and reduces the recurrence of hydrocephalus.[13] Additionally, a study corroborated these findings, showing that pediatric patients have better long-term outcomes after secondary ETV.[14]

On the other hand, patients over the age of 40 showed lower success rates, likely due to reduced ventricular compliance leading to shunt idling and challenges in achieving a functional stoma in older patients. Studies highlighted that older age is associated with lower success rates in secondary ETV procedures, suggesting that age is a critical factor in patient selection for this procedure.[15,16] This is further supported by another study, which noted that older age significantly reduces the likelihood of a successful secondary ETV in their cohort.[17]

One of the important factors identified in our study was the use of the preoperative ETV Success Score (ETVSS), which correlated with improved outcomes. This finding is similar to previous studies, which proved that the ETV success score is a reliable tool for predicting surgical success.[17,18] Higher ETVSS scores, showing more favorable conditions for CSF flow restoration, were associated with a decreased need for further surgical interventions. Studies also showed the predictive value of the ETVSS in determining patient outcomes following secondary ETV.[19,20]

As far as complications are concerned, the study found that CSF leaks (9.4%) and infections (6.3%) were relatively less frequent. These rates were consistent with the findings of studies that reported similar incidence rates of CSF leaks (5-10%) and infections (2-7%) after ETV procedures.[21,22] Importantly, these complications were generally treatable and less severe compared to those typically associated with repeated VP shunt revisions. This further supports the safety profile of secondary ETV as an alternative to shunt revision, as it decreases the long-term risks related to shunt dependency, such as infection, mechanical failure, and the need for repeat surgeries. Studies also confirmed the relatively rare complication rates after secondary ETV, suggesting that the procedure is safe with manageable risks.[4,23]

CONCLUSION

In conclusion, this study supports the current recognition of secondary ETV as an effective, shunt-free option for managing obstructive hydrocephalus, particularly in younger patients and those with higher preoperative ETVSS scores.

Recommendation

The procedure offers a good option for reducing reliance on shunts, thereby avoiding long-term complications.

Limitation

Retrospective studies which include not having enough population, further prospective trials with larger patient cohorts are needed to refine patient selection criteria, gain deeper insights into long-term outcomes, and optimize surgical techniques.

Ethical Statement

This study was conducted following the Declaration of ethical guidelines. Ethical approval was obtained from the Institutional Review Board of the respective hospital. The data was collected from patients with informed consent.

Disclosure Statement

The authors declare no conflict of interest related to this study.

Funding Statement

This research received no external funding.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

ACKNOWLEDGMENT

The authors wish to acknowledge the contributions of the neurosurgical team and the patients who participated in this study.

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Additional Information

Disclosures: Authors report no conflict of interest.
Ethical Review Board Approval: The study was conformed to the ethical review board requirements.
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

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Iqbal Ahmad	1. Study design and methodology
2.	Shakeel Ahmad Mashori	2. Paper writing, editing and quality insurer
3.	Muhammad Hasan Raza	3. Data collection and calculations
4.	Muhammad Kashif Chishti	4. Analysis of data and interpretation of results
5.	Khitam Ul Haq	5. Editing, literature review and referencing