International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

ICP Monitoring After ETV: A Prospective Study to Predict ETV Outcomes

Chaitanya Prabhu K[1], Harish HB[2], Hariprakash K Chakravarthy[3], Bal Krishna Ojha[4], Chhitij Srivatsava[5]

[1]Assistant professor, Department of Neurosurgery, BGS Medical College Hospital, Nagarur, Nelamangala, Bengaluru
[2]Assistant professor, Department of Neurology, BGS Medical College Hospital, Nagarur, Nelamangala, Bengaluru
[3]Associate Professor, Department of Neurosurgery, BGS Medical College Hospital, Nagarur, Nelamangala, Bengaluru
[4]Professor and head, Department of Neurosurgery, KGMU, Lucknow
[5]Professor, Department of Neurosurgery, KGMU, Lucknow

OPEN ACCESS

Corresponding Author:

Dr. Chaitanya Prabhu K
Assistant professor, Department of Neurosurgery, BGS Medical College Hospital, Nagarur, Nelamangala, Bengaluru
Email id:
chaitanyaprabhubmc@gmail.com

Received: 20-01-2026
Accepted: 15-04-2026
Available online: 31-05-2026

ABSTRACT

Background: Endoscopic third ventriculostomy (ETV) is an established treatment modality for obstructive hydrocephalus; however, early prediction of postoperative success remains challenging. Conventional radiological assessment and isolated intracranial pressure (ICP) measurements have shown limited reliability in identifying ETV failure during the early postoperative period. Continuous postoperative ICP monitoring may provide better insight into cerebrospinal fluid dynamics and functional outcome after ETV.

Objectives: To evaluate whether postoperative ICP trends predict ETV outcomes after ETV. Secondary objectives included comparison of predictive ability between ICP trends and individual ICP values, determination of sensitivity and specificity of ICP patterns, and evaluation of postoperative ICP trend evolution.

Methods: This prospective observational study was conducted in the Department of Neurosurgery, King George's Medical University, Lucknow, between January 2016 and July 2016. Forty-five patients undergoing ETV for hydrocephalus of various etiologies were included. Postoperative ICP monitoring was performed continuously for three days using an external ventricular drain connected to a pressure transducer. ICP trends were categorized as progressive increase, progressive decrease, stable, increase followed by decrease, and decrease followed by increase. ETV outcome was assessed clinically over a three-month follow-up period.

Results: Among 41 patients available for final follow-up, 24 (58.5%) had successful ETV outcomes and 17 (41.5%) experienced ETV failure. Progressive decrease and stable ICP trends were strongly associated with successful ETV outcomes, whereas progressive increase trend was significantly associated with ETV failure ($p < 0.001$). Progressive increase trend demonstrated sensitivity of 91.7% and specificity of 79.3% for predicting ETV failure. In contrast, individual ICP parameters, including daily average ICP values, did not demonstrate statistically significant association with ETV outcome.

Conclusion: Postoperative ICP trend analysis is a reliable predictor of ETV outcome and demonstrates superior predictive utility compared with isolated postoperative ICP measurements. Continuous ICP monitoring may facilitate early identification of patients at risk of ETV failure and aid timely postoperative management.

Keywords*: Endoscopic third ventriculostomy; intracranial pressure; hydrocephalus; ICP trends; cerebrospinal fluid dynamics; postoperative monitoring; ETV outcome.*

INTRODUCTION

Endoscopic third ventriculostomy (ETV) has become an established surgical treatment for obstructive hydrocephalus and is increasingly preferred over ventriculoperitoneal shunting because it restores near-physiological cerebrospinal fluid (CSF) circulation without the need for permanent implanted hardware.[1,2] The reported success rates of ETV vary widely, ranging from 50% to 95%, depending on patient age, etiology, and prior shunt status.[1–4] Despite its widespread use, predicting postoperative ETV success remains a major clinical challenge.

Early postoperative evaluation following ETV is often difficult because radiological and clinical findings may not accurately reflect stoma functionality. Ventricular size reduction after ETV is frequently delayed or minimal even in clinically successful cases.[5] Furthermore, cine phase-contrast magnetic resonance imaging (MRI), though useful in demonstrating CSF flow across the ventriculostomy stoma, does not reliably predict long-term outcome and may show persistent flow even in failed cases.[6] Transcranial Doppler-derived pulsatility indices have also shown inconsistent correlation with intracranial pressure (ICP) and ETV patency.[7,8]

Several predictive models and scoring systems have been proposed to estimate ETV success. Among these, the Endoscopic Third Ventriculostomy Success Score (ETVSS) has demonstrated moderate predictive utility, particularly in pediatric populations.[9–11] However, these tools are primarily based on demographic and etiological variables and do not directly evaluate postoperative CSF dynamics.

Postoperative ICP monitoring has emerged as a potentially valuable method for assessing early ETV function. Frim et al. first demonstrated characteristic postoperative ICP adaptation following successful ETV and described gradual normalization of ventricular pressure after surgery.[12] Subsequently, Bellotti et al. reported that postoperative ICP monitoring may help identify patients who develop intracranial hypertension after ETV.[13] Rapana et al. further demonstrated that postoperative ICP evolution varies according to hydrocephalus etiology and may provide important insights into postoperative CSF hydrodynamics.[14] Cinalli et al. observed that transient postoperative ICP elevation may occur even in clinically successful ETV cases due to delayed adaptation of subarachnoid CSF pathways.[15] Santamarta et al. and Korshunov et al. similarly reported progressive postoperative ICP reduction after successful ETV procedures.[16,17] More recently, Roytowski et al. demonstrated that postoperative ICP monitoring may improve prediction of early ETV functional outcome.[18]

Despite these observations, limited prospective studies have specifically evaluated the predictive role of postoperative ICP trend patterns compared with isolated ICP measurements. Therefore, the present study aimed to evaluate whether postoperative ICP trends can predict ETV outcome and to determine the diagnostic performance of different ICP trend patterns following ETV.

MATERIAL AND METHODS

This prospective single-center observational study was conducted in the Department of Neurosurgery, King George's Medical University (KGMU), Lucknow, India, between January 2016 and July 2016. The study included patients undergoing endoscopic third ventriculostomy (ETV) for hydrocephalus of various etiologies. Patients with previous failed ETV procedures were also included. Patients older than 70 years of age, those unwilling to participate in the study, and cases in which ETV could not be successfully completed were excluded from the analysis.

A total of 45 consecutive patients who underwent ETV during the study period were enrolled. Preoperative demographic, clinical, and radiological details were recorded for all patients. Hydrocephalus was classified as communicating or obstructive based on neuroimaging findings and clinical assessment.

All procedures were performed under standard operative protocols. At the completion of ETV, an external ventricular drain (EVD) catheter was placed through the same burr hole into the lateral ventricle under strict aseptic precautions. The EVD catheter was connected to a pressure transducer and bedside monitor (PHILIPS IntelliVue MP40; Philips Medical Systems, Netherlands) for continuous postoperative intracranial pressure (ICP) monitoring.

Postoperative ICP values were recorded every 30 minutes for three consecutive postoperative days. A total of 48 ICP readings were obtained each day, and these values were averaged to calculate the daily average value (DAV). To improve reliability and reduce variability, the averages of the five highest ICP values and five lowest ICP values recorded each day were also calculated and designated as high daily average value (HDAV) and low daily average value (LDAV), respectively.

Based on the evolution of DAV over the first three postoperative days, postoperative ICP trends were categorized into five patterns: progressive increase, progressive decrease, stable trend, increase followed by decrease, and decrease followed by increase. Progressive increase and progressive decrease trends were defined by continuous rise or fall in DAV from postoperative day 1 to day 3, respectively. Stable trend was defined as variation within ±1 mmHg during the monitoring period.

Computed tomography (CT) of the brain was performed at discharge and repeated when clinically indicated, particularly in patients with symptoms suggestive of raised ICP. Lumbar puncture or CSF drainage through the EVD was performed in selected symptomatic patients with elevated ICP values at the discretion of the operating neurosurgeon. The ICP monitoring system was removed after three postoperative days or earlier if repeat CSF diversion became necessary.

Patients were followed for a period of three months following surgery. Follow-up evaluations were performed at 15 days after discharge and at three months postoperatively. Clinical improvement, persistence or recurrence of symptoms of raised ICP, and requirement for repeat CSF diversion procedures were documented. ETV failure was defined as lack of postoperative clinical improvement and/or requirement for repeat CSF diversion procedure, including repeat ETV or ventriculoperitoneal shunt placement.

Data were entered into Microsoft Excel and analyzed using SPSS version 22.0 (IBM SPSS Statistics, Somers, NY, USA). Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as frequency and percentage. Comparisons between categorical variables were performed using the chi-square test or Fisher's exact test, as appropriate. Continuous variables between successful and failed ETV groups were compared using the independent samples t-test. Diagnostic performance of postoperative ICP trend patterns for predicting ETV outcome was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 45 patients underwent endoscopic third ventriculostomy (ETV) during the study period. Four patients were lost to follow-up and excluded from the final outcome analysis. Therefore, 41 patients were included in the final analysis, among whom 24 patients (58.5%) had successful ETV outcomes, while 17 patients (41.5%) experienced ETV failure.

The majority of patients belonged to the pediatric age group, with 21 patients aged less than 1 year. Male patients constituted the predominant study population. Obstructive hydrocephalus was more common than communicating hydrocephalus. Aqueductal stenosis and tubercular meningitis with hydrocephalus were the most common etiologies observed in the cohort. However, no statistically significant association was observed between ETV outcome and age group, gender, congenital versus acquired hydrocephalus, or type of hydrocephalus (Table 1).

Five postoperative intracranial pressure (ICP) trend patterns were identified following ETV: progressive decrease, progressive increase, stable trend, increase followed by decrease, and decrease followed by increase. Progressive decrease was the most common favorable pattern, observed in 14 patients, of whom 12 (85.7%) had successful ETV outcomes. Similarly, a stable ICP trend was associated with favorable outcome in 9 of 11 patients (81.8%).

In contrast, progressive increase in ICP was strongly associated with ETV failure and was observed in 12 patients, among whom 11 patients (91.7%) experienced ETV failure. Overall, postoperative ICP trend patterns demonstrated a statistically significant association with ETV outcome ($\chi^2 = 20.572$, $p < 0.001$) (Table 2).

Diagnostic accuracy analysis demonstrated that a progressive decrease trend predicted successful ETV with a sensitivity of 85.7% and a negative predictive value (NPV) of 88.2%. A stable trend similarly demonstrated high sensitivity (81.8%) and NPV (88.2%) for predicting successful ETV outcome.

When progressive decrease and stable trends were combined, the predictive performance improved substantially, with a sensitivity of 84.0%, specificity of 81.3%, positive predictive value (PPV) of 87.5%, and NPV of 76.5%.

Progressive increase trend demonstrated the highest predictive accuracy for ETV failure, with sensitivity of 91.7%, specificity of 79.3%, and NPV of 95.8% (Table 3).

Daily average ICP values (DAV), high daily average values (HDAV), and low daily average values (LDAV) were compared between successful and failed ETV groups. Although patients with failed ETV demonstrated relatively higher DAV and HDAV values during the postoperative period, none of the individual ICP parameters showed statistically significant association with ETV outcome.

The mean DAV on postoperative day 3 was higher in the failed ETV group compared with the successful group (9.08 ± 5.88 mmHg vs 6.24 ± 3.86 mmHg), although this difference did not reach statistical significance ($p = 0.069$). Similar nonsignificant findings were observed for HDAV and LDAV parameters (Table 4).

Overall, postoperative ICP trend evolution demonstrated superior predictive utility compared with isolated postoperative ICP measurements in determining ETV outcome.

Table 1. Baseline demographic and clinical characteristics of patients undergoing ETV according to outcome

Variable	Successful ETV (n = 24)	Failed ETV (n = 17)	p-value

Age (years)	≤1 year	11 (45.8)	10 (58.8)	
	1–18 years	9 (37.5)	5 (29.4)	
	>18 years	4 (16.7)	2 (11.8)	
Male Gender, n (%)		13 (54.2)	12 (70.6)	0.288
Hydrocephalus	Congenital hydrocephalus	10 (41.7)	7 (41.2)	0.975
	Acquired hydrocephalus	14 (58.3)	10 (58.8)	
	Obstructive hydrocephalus	19 (79.2)	10 (58.8)	0.158
	Communicating hydrocephalus	5 (20.8)	7 (41.2)	
	Aqueductal stenosis	6 (25.0)	7 (41.2)	#0.319
	Tubercular meningitis with hydrocephalus	2 (8.3)	6 (35.3)	#0.058

Chi square test, #Fisher's exact test

Table 2. Association between postoperative ICP trend patterns and ETV outcome

ICP trend pattern	**Total (n = 41)**	**Successful ETV, n (%)**	**Failed ETV, n (%)**	**p-value**
Progressive decrease	14	12 (85.7)	2 (14.3)	**<0.001***
Stable trend	11	9 (81.8)	2 (18.2)	
Progressive increase	12	1 (8.3)	11 (91.7)	
Increase followed by decrease	3	1 (33.3)	2 (66.7)	
Decrease followed by increase	1	1 (100.0)	0 (0.0)	

Chi square test

Table 3. Diagnostic performance of postoperative ICP trend patterns in predicting ETV outcome

ICP trend pattern	**Sensitivity (%)**	**Specificity (%)**	**Positive predictive value (%)**	**Negative predictive value (%)**
Progressive decrease predicting ETV success	85.71	55.56	50	88.24
Stable trend predicting ETV success	81.82	50	37.5	88.24
Progressive decrease + stable trend predicting ETV success	84	81.25	87.5	76.47
Progressive increase predicting ETV failure	91.67	79.31	64.71	95.83

Table 4. Comparison of individual postoperative ICP values between successful and failed ETV outcomes

ICP parameter (mmHg)		**Successful ETV (n = 24) Mean ± SD**	**Failed ETV (n = 17) Mean ± SD**	**p-value**
DAV	Day 1	7.74 ± 4.92	7.55 ± 4.71	0.905
	Day 2	7.28 ± 4.83	8.31 ± 5.71	0.536
	Day 3	6.24 ± 3.86	9.08 ± 5.88	0.069
	Mean DAV	7.08 ± 4.21	8.31 ± 5.29	0.413
HDAV	Day 1	11.88 ± 6.53	13.13 ± 6.60	0.550
	Day 2	10.83 ± 6.59	13.14 ± 8.07	0.319
	Day 3	9.25 ± 4.57	13.09 ± 8.45	0.068
	Mean HDAV	10.65 ± 5.50	13.12 ± 7.49	0.230
LDAV	Day 1	3.93 ± 3.11	4.09 ± 5.24	0.903
	Day 2	4.55 ± 4.09	5.71 ± 5.84	0.460
	Day 3	3.92 ± 3.29	5.97 ± 5.75	0.155
	Mean LDAV	4.13 ± 3.24	5.26 ± 5.47	0.415

Independent samples t-test

DISCUSSION

The present study evaluated the role of postoperative ICP trends in predicting outcomes following endoscopic third ventriculostomy. The principal finding of this study was that dynamic postoperative ICP trend evolution demonstrated significantly greater predictive utility than isolated ICP measurements.

In the present series, the overall ETV success rate was 58.5%, which is comparable with previously reported success rates ranging from 50% to 95% in the literature.[1–4] Similar to previous reports, no statistically significant association was observed between ETV outcome and demographic variables such as age or gender.[2,3] Although obstructive hydrocephalus demonstrated relatively higher success rates than communicating hydrocephalus, this difference did not achieve statistical significance.

The most important finding of the current study was the strong association between postoperative ICP trend patterns and ETV outcome. Progressive decrease and stable ICP trends were predominantly associated with successful ETV outcomes, whereas progressive increase trend strongly correlated with ETV failure. This observation supports earlier findings by Rapana et al., who demonstrated that postoperative ICP evolution reflects changing CSF hydrodynamics after ETV and may differ among patient groups.[14] Similarly, Santamarta et al. observed progressive reduction in postoperative ICP after successful ETV procedures, particularly in acute hydrocephalus and pediatric patients.[16] Korshunov et al. also reported reduction in postoperative ICP and improvement in CSF outflow resistance following successful ETV.[17]

The present study further demonstrated that progressive increase trend had high sensitivity (91.7%) and specificity (79.3%) for predicting ETV failure. These findings are clinically important because postoperative deterioration following failed ETV can occasionally be sudden and life-threatening. Roytowski et al. similarly reported that postoperative ICP monitoring has high negative predictive value in identifying functional ETV outcomes.[18] Bellotti et al. previously emphasized the utility of postoperative ICP monitoring in identifying patients who develop postoperative intracranial hypertension requiring intervention.[13]

An important observation in the present study was that individual ICP parameters, including daily average values (DAV), high daily average values (HDAV), and low daily average values (LDAV), did not significantly correlate with ETV outcome. Although failed ETV cases demonstrated relatively higher ICP values, isolated measurements lacked sufficient discriminatory value. This finding suggests that postoperative ICP evolution over time is more informative than single ICP readings. Similar physiological adaptation after successful ETV was previously described by Frim et al., who proposed that gradual normalization of ICP reflects adaptation of CSF circulation pathways and restoration of intracranial compliance.[12] Cinalli et al. also demonstrated that transient postoperative ICP elevation may occur even in successful ETV due to delayed subarachnoid adaptation.[15]

The findings of the current study support the concept that postoperative ICP monitoring provides a dynamic assessment of CSF circulation following ETV rather than merely reflecting static pressure values. Trend analysis appears to better characterize the physiological response to ventriculostomy and may aid in early identification of patients at risk of ETV failure.

The present study has certain limitations. The sample size was relatively small, and the follow-up duration was limited to three months. In addition, the study was conducted at a single center, which may limit generalizability. Nevertheless, the prospective design and continuous postoperative ICP monitoring strengthen the validity of the observations.

Overall, the present study demonstrates that postoperative ICP trend evolution is a reliable predictor of ETV outcome and provides superior predictive utility compared with isolated postoperative ICP measurements.

CONCLUSION

Postoperative intracranial pressure (ICP) trend analysis is a valuable predictor of outcome following endoscopic third ventriculostomy (ETV). Progressive decrease and stable ICP trends were strongly associated with successful ETV outcomes, whereas progressive increase trend demonstrated high predictive accuracy for ETV failure. In contrast, isolated postoperative ICP measurements did not show significant association with outcome, suggesting that dynamic ICP evolution provides superior clinical information compared with single ICP values. Continuous postoperative ICP monitoring may therefore aid in early identification of patients at risk of ETV failure and facilitate timely intervention. Larger multicentric studies with longer follow-up are warranted to validate these findings.

REFERENCES

1. Drake JM. Endoscopic third ventriculostomy in pediatric patients: the Canadian experience. Neurosurgery. 2007;60(5):881-6.
2. Kadrian D, van Gelder J, Florida D, Jones R, Vonau M, Teo C, et al. Long-term reliability of endoscopic third ventriculostomy. Neurosurgery. 2005;56(6):1271-8.
3. Kulkarni AV, Drake JM, Kestle JRW, Mallucci CL, Sgouros S, Constantini S. Predicting who will benefit from endoscopic third ventriculostomy compared with shunt insertion in childhood hydrocephalus using the ETV Success Score. J Neurosurg Pediatr. 2010;6(4):310-5.
4. Cinalli G, Sainte-Rose C, Chumas P, Zerah M, Brunelle F, Lot G, et al. Failure of third ventriculostomy in the treatment of aqueductal stenosis in children. J Neurosurg. 1999;90(3):448-54.
5. O'Brien DF, Javadpour M, Collins DR, Spennato P, Mallucci CL. Endoscopic third ventriculostomy: an outcome analysis of primary cases and procedures performed after ventriculoperitoneal shunt malfunction. J Neurosurg. 2005;103(5 Suppl):393-400.
6. Faggin R, Calderone M, Denaro L, Meneghini L, d'Avella D. Long-term operative failure of endoscopic third ventriculostomy in pediatric patients: the role of cine phase-contrast MR imaging. Neurosurg Focus. 2011;30(4):E1.

7. Vajda Z, Pedro MT, Kappus C, Lipka J, Ebner FH. Transcranial Doppler-determined pulsatility index in the follow-up of endoscopic third ventriculostomy. Acta Neurochir (Wien). 2001;143(12):1239-45.
8. Behrens S, Daffertshofer M, Spiegel D, Hennerici M. Transcranial Doppler ultrasonography and intracranial pressure: lack of significant correlation. J Neurol Sci. 1999;163(2):161-5.
9. Kulkarni AV, Drake JM, Mallucci CL, Sgouros S, Roth J, Constantini S. Endoscopic third ventriculostomy success score: an internally validated tool to predict the success of ETV in children. J Neurosurg Pediatr. 2009;4(4):310-5.
10. Durnford AJ, Kirkham FJ, Mathad N, Sparrow OC. The long-term predictive value of the ETV Success Score in pediatric hydrocephalus. Childs Nerv Syst. 2011;27(12):2133-7.
11. Naftel RP, Reed GT, Kulkarni AV, Wellons JC III. Evaluating the Children's Hospital of Alabama endoscopic third ventriculostomy experience using the Endoscopic Third Ventriculostomy Success Score: an external validation study. J Neurosurg Pediatr. 2011;8(5):494-501.
12. Frim DM, Scott RM, Madsen JR. Intracranial pressure dynamics of endoscopic third ventriculostomy. J Neurosurg. 1997;86(4):698-701.
13. Bellotti C, Fiorindi A, Pavesi G, Galzio R. The role of intracranial pressure monitoring in the postoperative management of endoscopic third ventriculostomy. Acta Neurochir (Wien). 2001;143(1):51-63.
14. Rapana A, Bianchi F, Stifano V, Santi M. Endoscopic third ventriculostomy and postoperative intracranial pressure monitoring. Neurosurg Rev. 2004;27(4):266-71.
15. Cinalli G, Salazar C, Mallucci C, Yada JZ, Zerah M, Sainte-Rose C. The role of lumbar puncture after endoscopic third ventriculostomy in the management of sustained intracranial hypertension. Neurosurgery. 2006;58(1):126-36.
16. Santamarta D, Martin-Vallejo J, Diaz-Alvarez A, Maillo A. Changes in intracranial pressure after endoscopic third ventriculostomy. Neurosurgery. 2005;56(2):355-63.
17. Korshunov A, Likhterman L, Pronin I, Okishev D. Cerebrospinal fluid dynamics in chronic obstructive hydrocephalus after endoscopic third ventriculostomy. Acta Neurochir Suppl. 2008;102:329-32.
18. Roytowski D, Figaj M, Chmielik LP. Predicting functional outcome after endoscopic third ventriculostomy using postoperative intracranial pressure monitoring. Childs Nerv Syst. 2013;29(7):1177-84.