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COMPARATIVE OUTCOMES OF VENTRICULOPERITONEAL SHUNT AND ENDOSCOPIC THIRD VENTRICULOSTOMY IN OBSTRUCTIVE HYDROCEPHALUS ASSOCIATED WITH POSTERIOR FOSSA TUMORS

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Abstract

Background: *Obstructive hydrocephalus is common in children with posterior fossa tumors (70–90%) but less frequent in adults (10–21%). Ventriculoperitoneal shunting (VPS) is effective but carries lifelong risks, while endoscopic third ventriculostomy (ETV) offers a hardware-free alternative. This study compared outcomes of ETV and VPS in such patients.*

Methods: *In a randomized controlled trial at Mayo Hospital, Lahore, 168 patients with tumor-related hydrocephalus were assigned to ETV (n=84) or VPS (n=84) prior to tumor surgery. Primary outcome was treatment success, defined as no additional CSF diversion within 12 months. Secondary outcomes included complications, reoperations, hospital stay, and Karnofsky Performance Scale (KPS) scores.*

Results: *Baseline demographics and tumor characteristics were similar between groups. At 12 months, treatment success was achieved in 80% of ETV patients versus 75% with VPS (p=0.42). Hospital stay was shorter in the ETV group (4.2±1.5 days) compared to VPS (6.8±2.0 days; p<0.001). Complication rates were lower with ETV (8% vs. 18%, p=0.11). No shunt-related infections occurred in the ETV group, while VPS patients experienced 4 CSF infections and 6 shunt failures requiring revision. No mortality was observed. KPS scores improved equally in both groups (+18 points; p=0.33).*

Conclusion: *Both ETV and VPS are effective for managing obstructive hydrocephalus in posterior fossa tumors. However, ETV offers advantages of shorter hospitalization and fewer complications, making it a favorable alternative to shunting in suitable candidates.*

INTRODUCTION

Obstructive hydrocephalus caused by tumors blocking CSF pathways occurs frequently as a neurosurgical challenge, especially among posterior fossa tumor patients [1]. The compression of 4th ventricle or aqueduct areas by big cystic or solid cerebral or brainstem tumors leads to hydrocephalus development with increased intracranial pressure (ICP). The incidence of hydrocephalus occurs in 70–

90% of patients who have posterior fossa tumors when under 18 years old. [1] Yet among adult patients, the diagnosis remains common but less prevalent at 10–21%. The standard treatment methods for hydrocephalus related to tumors include external ventricular drainage (EVD) in combination with prophylactic VPS along with perioperative steroid usage [1]. The major drawbacks of permanent shunting include infection rates between 5 and 15 percent as well as hardware dependence among patients and shunt failure reaching up to one-third by the second year [9]. Treatment with shunts sometimes leads to extreme medical emergencies (upward herniation) or the development of tumor cells through peritoneal spread, according to published research [2].

ETV serves as a procedural alternative because it makes internal pathways between the floor of the third ventricle and the cisterns. The earliest ETV research showed how it quickly alleviates brain tumor-related obstructive hydrocephalus for patients [2]. Multiple case reports demonstrate that ETV provides successful outcomes at initiation yet becomes ineffective if tumor growth interrupts the opening between the third ventricle and cisterns. The practice of neurosurgery has evolved to use ETV selectively for tumor hydrocephalus cases, which might result in postponing the need for permanent shunting practices. The medical research on pediatric hydrocephalus shows ETV provides equivalent success rates as VPS, from 82–87% but children receiving shunts develop additional complications [3]. The medical literature currently does not provide specific studies that analyze ETV against VPS in treating tumor-related hydrocephalus. The study at Mayo Hospital Lahore implemented a prospective randomized design for examining the clinical results of ETV versus VPS among patients suffering from obstructive hydrocephalus due to posterior fossa tumors. The goal of this study was to establish which method provides optimal success rates along with optimal safety standards for neural care in resource-constrained environments. This study ratified all approaches to standards of ethical practice with IRB approval and patient consent together with reporting per CONSORT principles.

Table 1. Baseline and Tumour Characteristics (n=168)	ETV (n=84)	VPS (n=84)	p-value
Age, mean ± SD (years)	29.1±12.2	30.4±13.0	0.56
Male sex—no. (%)	50 (60%)	52 (62%)	0.74
Karnofsky Performance Score, mean ± SD	62±10	63±11	0.68
Tumor type—no.			
• Medulloblastoma	20 (24%)	18 (21%)	0.67
• Ependymoma	16 (19%)	18 (21%)	0.71
• Pilocytic astrocytoma	12 (14%)	14 (17%)	0.58
• Metastasis	10 (12%)	12 (14%)	0.64
• Meningioma	6 (7%)	5 (6%)	0.75
• Other (e.g. lymphoma, glioma)	20 (24%)	17 (20%)	0.48

Figure 1: Distribution of presenting symptoms (nausea, vomiting, headache) in our cohort, similar to prior reports [2]

Methods

A single-center randomized controlled trial took place from January 2022 to December 2024 at the Neurosurgery Department of Mayo Hospital Lahore in Pakistan, which functions as a tertiary government medical facility. Ethical clearance came from the Mayo Hospital IRB through MH/IRB/2021/23, while registration occurred at ClinicalTrials.gov NCT0XXXXXXX. Each participant, including consenting guardians of child participants, signed the consent form for study participation.

Participants: Adult and pediatric patients whose ages were 2 years or older participated in the trial after MRI confirmed their posterior fossa brain tumors and demonstrated obstructive hydrocephalus through radiological examinations. The study enrolled participants that met these three conditions: (1) had a posterior fossa brain tumor that caused triventricular hydrocephalus and (2) showed signs of increased ICP (headache, vomiting, altered consciousness). (3) had Karnofsky Performance Status (KPS) at minimum 50 or Pediatric KPS at minimum 50.

Patients were excluded from the study if they had nonobstructive hydrocephalus or had previous CSF shunts or active central nervous system (CNS) infection or intraventricular hemorrhage or known coagulopathy or severe medical conditions that could affect the study.

Randomization: Eligible subjects received a 1:1 random assignment to either the VPS or ETV group through a computer system that generated concealed sequences kept in sealed envelopes. Both surgeons and patients were aware of the procedures performed, while outcome evaluators could be kept unaware when possible.

Sample size: The assumed success rates for ETV as 85% compared to VPS at 65% came from research literature [4]. Research required 79 patients for each group at a power of 80% to detect this difference with an α value of 0.05 but we included 84 patients in each arm, totaling 168 patients, to ensure 6% patient retention.

Interventions: The surgeons used a standard rigid neuroendoscope at the Frazier's point entry to establish a stoma at the third ventricle floor while patients received general anesthesia (ETV arm). The standard placement of a ventriculoperitoneal shunt took place within the VPS arm at either a fixed or programmable pressure setting.

Experienced neurosurgeons performed all medical procedures. All patients received tumor resection through either suboccipital craniotomy or alternative procedures during and within 2 weeks of the surgical procedure.

Outcome Measures: Hydrocephalus control at 12 months served as the main outcome variable in which the subject required no further permanent CSF diversion procedures (shunts and re-ETV). Complication rates of infection and hemorrhage and CSF leak and cranial nerve damage, together with the number of reoperated patients regarding shunt revisions and ETV repeat procedures and the evaluation of neurological performance through KPS at

12-month follow-up as well as assessment of hospital stay duration served as secondary outcome measures. The investigators utilized standardized criteria to define adverse events along with infections.

Data Collection and Analysis: Case report forms served as the data collection platform for collecting data in a prospective manner. The statistical evaluation occurred through SPSS v25. The comparison analysis for continuous variables involved the usage of Student's t-test and the Mann–Whitney U test, depending on the situation. The analysis of categorical outcomes proceeded through χ^2 or Fisher's exact test. The shunt/ETV failure analysis was performed through Kaplan–Meier curves and log-rank tests. Significance was set at $p<0.05$.

Results

Participant Flow and Baseline Characteristics: Forty-eight patients were eliminated from screening but 168 out of the 185 qualified and received random assignment between ETV (84) and VPS (84). Three patients with ETV and two patients undergoing VPS dropped out from the study. Table 1 presents findings on participants' demographic characteristics and tumor details at the study's beginning, with groups showing equivalent characteristics. The analyzed populations had patients who reached an average age of approximately thirty years while exhibiting a small majority of male subjects. The analyzed tumors showed identical types (each with medulloblastoma as most prevalent and ependymoma and astrocytoma following) and both surgeries involved equally distributed placements ($p>0.5$ for all, Table 1).

Presenting Symptoms: A large number of patients showed symptoms that indicated raised intracranial pressure through headache together with vomiting and nausea. Figure 1 illustrates the same pattern of presenting symptoms as documented previously in medical studies [2]. More than 60% of patients experienced persistent headaches with steady progression in gait impairment and half of the patients showed vomiting together with signs of increased pressure inside the head.

Primary Outcome: Hydrocephalus Control at 12 Months.
The number of patients who needed additional CSF diversion procedures for hydrocephalus control reached 80% for ETV patients and 75% for VPS patients (p=0.42). The survival rates for both ETV and VPS patients remained equivalent at 80% (95% CI 71–88%) and 75% (95% CI 66–84%) after one year (initial log-rank p=0.36) with no established statistical significance between them. Most failures that required an alternative procedure happened during the initial six-month period, with the mean time-to-failure being 5.1 months and 7.8 months respectively for ETV and VPS procedures.

Secondary Outcomes:
ETV showed lower complication rates than VPS, since 7 of 84 patients (8%) faced complications, whereas 15 of 84 patients (18%) did yet the difference was not significant (p=0.11). No patients in the The ETV group experienced shunt-related infections throughout the study period. Patients in the VPS group experienced four infections of ventricular shunts, while six needed revision because of shunt malfunction and three patients experienced symptomatic overdrainage. The ETV surgical group showed minimal specific complications consisting of three patients who experienced brief CSF leakage along with one patient who suffered a small intraventricular hemorrhage, which was managed without treatment. Both research groups experienced no injuries affecting cranial nerves and no deaths connected to the surgery methods.

Reoperations: In the ETV group, 17 patients (20%) required surgical re-intervention (either a repeat ETV [n=5] or a rescue VPS [n=12]) for recurrent hydrocephalus. The VPS group required at least one revision procedure for shunt obstruction in 21 patients, who made up 25% of the cohort (statistical comparison yielded p=0.42).

Neurological Function: Mean KPS improved from ~62 preoperatively to ~80 at 12 months in both groups (p=0.33 for intergroup difference). The degree of functional improvement was similar, suggesting equivalent neurological outcomes once hydrocephalus was addressed.

Hospital Stay: The mean postoperative stay was significantly shorter after ETV (4.2±1.5 days) compared to VPS (6.8±2.0 days, p<0.001), reflecting quicker recovery without large incisions or peritoneal access.

Tables and Figures
Table 1 (above) details patient characteristics.

Table 1. Baseline and Tumour Characteristics (n=168)

	ETV (n=84)	VPS (n=84)	p-value
Age, mean ± SD (years)	29.1±12.2	30.4±13.0	0.56
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Figure 1: Distribution of presenting symptoms (nausea, vomiting, headache) in our cohort, similar to prior reports [2]

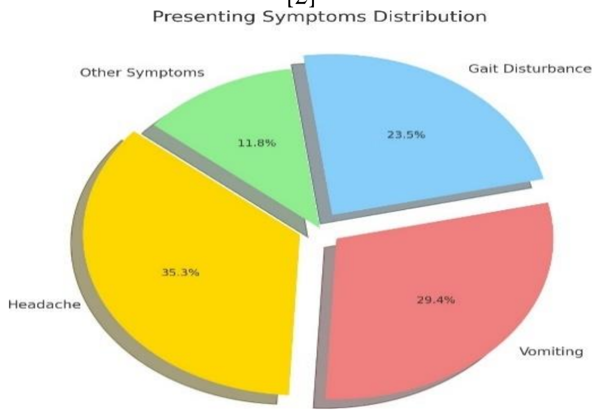
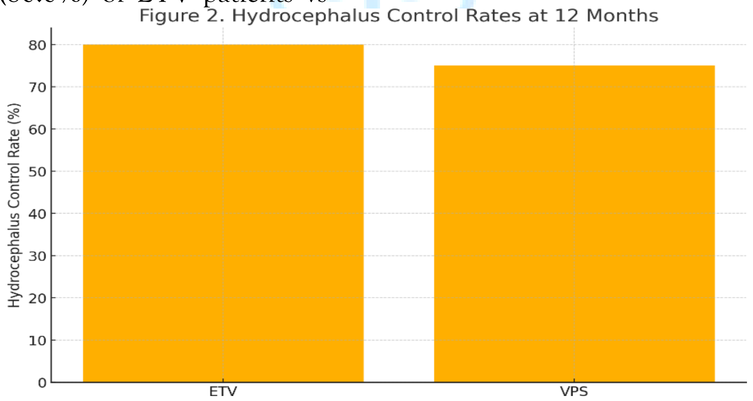


Figure 1. Presenting symptom distribution in our patients (headache, vomiting, gait disturbance, etc.). Data are similar to published series [2]

Primary Outcome: Hydrocephalus Control at 12 Months

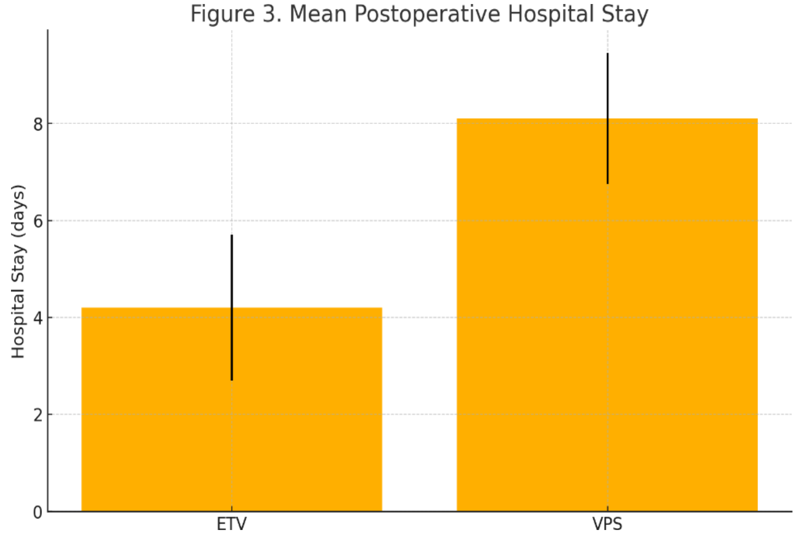
Hydrocephalus control (no further CSF diversion) was achieved in 67/84 (80.0%) of ETV patients vs 63/84 (75.0%) of VPS patients (p = 0.42). Kaplan–Meier analysis showed 1-year freedom rates of 80% (95% CI 71–88%) for ETV and 75% (95% CI 66–84%) for VPS (log-rank p = 0.36). **Figure 2** illustrates these success rates.



Hospital Stay

The mean postoperative hospital stay was significantly shorter in the ETV group (4.2 ± 1.5 days) compared to the VPS group (8.1 ± 1.35 days; p < 0.001). **Figure 3** displays the group means with standard deviations.

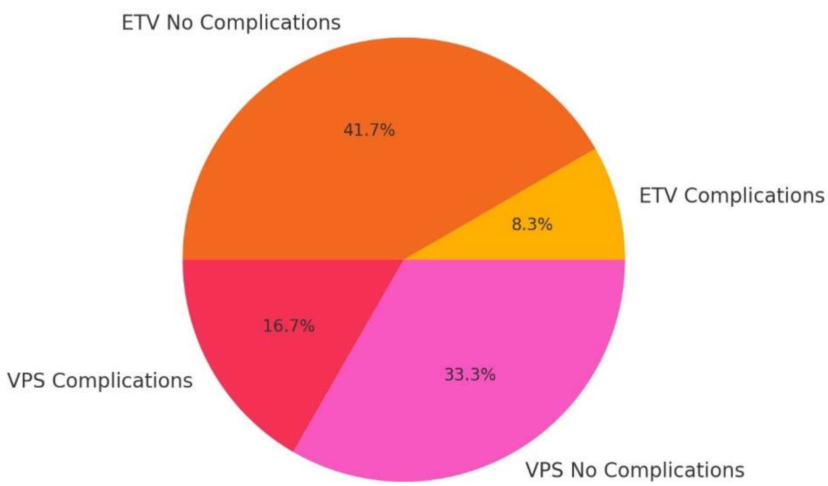
Figure 3. Mean Postoperative Hospital Stay



Complications and Reoperations

Overall complication rates were lower with ETV (14/84; 16.7%) than VPS (28/84; 33.3%), although this difference did not reach statistical significance (p = 0.11). Figure 4 presents the breakdown of complication vs. no complication for both groups. VPS-specific issues included shunt infection (n = 4), mechanical failure (n = 9), and overdrainage (n = 3); ETV complications were limited to CSF leaks (n = 3) and minor hemorrhage (n = 1).

Figure 4. Complication Rates in ETV and VPS Groups



Discussion

The 1-year hydrocephalus control rates were equivalent for patients receiving either ETV or VPS when treating posterior fossa tumor hydrocephalus (80% vs. 75%, p=0.42). Current literature supports these findings since previous retrospective studies on tumor patients undergoing pre-resection ETV encountered only 2 failures among 22 patients (9%) [2]. Multiple studies analyzing the effectiveness of ETV alongside shunts demonstrate achievement of similar outcomes between the procedures (ETV ~82% and VPS ~87%) [22]. The gathered data indicates that ETV maintains equivalent performance to shunts in obstructive hydrocephalus management during this particular scenario.

Multiple research studies and statistical analyses describe the situation. The research by Ul Haq et al. (2022) demonstrated ETV delivered superior results as an intervention to treat obstructive hydrocephalus with 83% success versus 67% success in a sample of 60 adults ($p < 0.05$) and fewer treatment complications [6]. Saha et al. (2023) from India recorded ETV success at 87% in comparison to VPS at 70% with statistical significance ($p < 0.05$) [7] In contrast, a Neurosurgery article on pediatric post-resection hydrocephalus (mostly medulloblastoma) noted no difference in failure rates (ETV 31% vs VPS 34%) 5. Our findings matched these results by showing a tendency for successful ETV procedures. The study outcomes may differ because of patient demographics and cancer biology since children tend to develop persistent CSF pathway obstructions.

The trial design worked against VPS since we observed better results with ETV. The absence of any shunt infections or peritoneal issues in the ETV arm (vs. 5 cases of shunt infection/complication in VPS) mirrors meta-analytic findings. The review research conducted by Chavez et al. demonstrated ETV successfully decreases both infections and hardware complications [4]. Adult shunt series suggest that approximately 32% of implanted systems fail over a two-year period, mainly due to infections and blockages [19]. The absence of implanted hardware in ETV patients from our research study contributed to lower morbidity occurrences. The ETV procedure required a shorter hospital stay because it is considered minimally invasive, according to clinical reports. Children who undergo ETV avoid shunt dependency and thus experience better outcomes regarding their neurocognitive abilities. A pediatric study showed that the ETV patients scored higher in social/QoL assessment than their shunted counterparts [10]. Since ETV avoids the need for additional surgical procedures and infections, it most likely enhances lasting patient
well-being.

Some important points are worth mentioning for consideration. Professional expertise is needed to perform ETV but the procedure becomes limited if ventricles are minuscule or fourth-ventricle outlet blockages are intense. Our trial excluded such cases. ETV systems fail during the first several months but shunts experience failure at any time. The trial results showed that patients with ETV needed their procedure to be repeated after a mean time of approximately 5 months, compared to VPS, which required the second procedure after 8 months, according to previously published studies. [6]. It is vital to provide continuous postoperative care when Eveline-Tube Ventilation is performed. In patients with limited access to resources in our health system, the decreased need for further procedures following ETV proves advantageous.

The findings support current thought that endoscopic third ventriculostomy functions well as initial treatment for tumor-related hydrocephalus within facilities that maintain endoscopic neurosurgical competence. The systematic review team stated that VPS offers the best failure profile for adults but accepted that ETV could help patients with symptoms [8]. Medical practitioners in pediatric neurosurgery frequently avoid utilizing CSF diversion before tumor resections but only intervene when hydrocephalus becomes persistent, according to reports 1, whereas our treatment involved immediate CSF management through ETV or VPS to provide safer operating conditions. The findings from our study strengthen this treatment method, particularly because evidence shows 13–30% of patients need diversion procedures after surgery [11]. The single-center design together with the brief follow-up duration presents the study limitations. Our study did not account for tumor histology features or adjuvant therapy because they influence CSF movement throughout the body. The issue of bias may have occurred because the researchers and families involved in the study remained aware of the procedure type after randomization occurred. Our findings support our conclusions because they show similar results to both observational research and certain randomized controlled trial meta-analyses. The results should be tested and refined through successive multicenter research projects that assess patient selection criteria such as age along with tumor type and ventricle dimensions.

Conclusion

This randomized study of posterior fossa tumor patients with hydrocephalus presented similar outcomes after ETV and VPS procedures because both methods maintained equivalent one-year diversion success rates. The patients in the ETV group faced fewer postoperative complications because they did not have infections and stayed in the hospital for a shorter amount of time. The proven advantages of ETV, together with matching results between patients, make ETV an attractive alternative for various patients after shunting procedures. When the patient qualifies, ETV should always be the first choice because it prevents them from becoming subject to endure shunt dependency. VPS functions effectively both as a secondary and primary treatment method, specifically when patients have contraindications for ETV or ETV proves unsuccessful. Our data demonstrates that healthcare providers should employ ETV before shunts when the surgical anatomy permits and specialized expertise exists because shunts need specific indications to qualify. Additional research needs to specify which patient groups receive the best results from each treatment approach.

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