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Comparison of Ventriculoperitoneal Shunt and Endoscopic Third Ventriculostomy In the Management of Obstructive Hydrocephalus

Muhammad Talha Makshoof, Maqsood Akram, Zahid Hussain, Ahmed Hassaan Malik, Asif Rasheed, Muhammad Usman

Department of Neurosurgery, Combined Military Hospital Rawalpindi /National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To compare the clinical success rate of ventriculoperitoneal shunt (VP shunt) and endoscopic third ventriculostomy (ETV) in the treatment of obstructive hydrocephalus.
Study Design: Quasi-experimental study.
Place and Duration of Study: Department of Neurosurgery, Combined Military Hospital (CMH) Rawalpindi, Pakistan, from Jul 2023 to Mar 2025.
Methodology: This study enrolled 100 patients presenting with radiologically confirmed obstructive (non-communicating) hydrocephalus, who were then divided into two groups of 50 patients each. Patients in Group-A (n=50) underwent VP shunting, while those in Group-B (n=50) were treated with ETV. All patients were followed till discharge and then weekly for first month and monthly for next five months. Clinical success rate was determined in terms of complications, re-operation and average hospital stay. Statistically significant association was determined by a p value <0.05.
Results: On follow up, neurological outcomes in terms of Glasgow Outcome Scale (GOS) scores were GOS 2 in 22 patients, GOS 3 in 30 patients, GOS 4 in 24 patients and GOS 5 in 24 patients. Clinical success rate was 94.00% in Group-A, while it was 96.00% in Group-B (p=0.646). Complication rate was 36.00% in Group-A as compared to 20% in Group-B (*p*=0.075). Re-operation rate was 48.00% in Group-A and 16.00% in Group-B (*p*=0.001), while average hospital stay duration was 8.10 ± 2.43 days in Group-A as compared to 5.42 ± 1.89 days in Group-B (*p*<0.001).
Conclusion: ETV provided better results as compared to VP shunt in management of obstructive hydrocephalus in our study in terms of average hospital stay and re-operation rate.

Keywords: Hydrocephalus, Neurosurgery, Ventriculostomy

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INTRODUCTION

Hydrocephalus is a common neurosurgical condition characterized by abnormal accumulation of cerebrospinal fluid (CSF) within the cerebral ventricles, leading to raised intracranial pressure and potential neurological compromise.[1] Obstructive (non-communicating) hydrocephalus results from mechanical blockage in the ventricular system and is frequently encountered in the Pakistani population due to aqueductal stenosis, tectal gliomas, or posterior fossa masses, due to blockage of CSF flow.[2] Two primary surgical modalities are used in the management of obstructive hydrocephalus: Ventriculoperitoneal (VP) shunting and Endoscopic Third Ventriculostomy (ETV).[3] VP shunting is a time-tested but complication-prone method involving implantation of a permanent device, which diverts CSF from the ventricles into the peritoneal cavity via an implantable valve system.[4] Despite its widespread adoption, up to 40% of pediatric shunts fail within two years due to obstruction, infection, or mechanical malfunction.[5] ETV is a physiological bypass of the obstruction using a neuro-endoscopic technique, which creates an internal CSF bypass by perforating the floor of the third ventricle, thereby obviating implanted hardware.[6] Recent studies have demonstrated 12-month success rates of around 80%, with lower long-term complication and revision rates compared to VP shunting.[7] While VP shunt remains the mainstay in infants and certain anatomical scenarios, ETV is gaining popularity, especially in older children and adults due to its avoidance of hardware and potentially lower long-term complications.[8] Studies have found ETV to be cost-effective in our setup, with reduced hospital stay and less complications but despite widespread use of both VP shunting and ETV, there is limited local data comparing their outcomes.[6] This study aims to compare the outcomes of these two treatment modalities in patients with obstructive hydrocephalus

Correspondence: Dr Muhammad Talha Makshoof, Department of Neurosurgery, Combined Military Hospital Rawalpindi Pakistan
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at a tertiary care neurosurgical center in Pakistan, to help in formulation of local neurosurgical practice guidelines and improve long-term outcomes.

METHODOLOGY

This was a quasi-experimental study, conducted at Department of Neurosurgery, CMH Rawalpindi, Pakistan, from July 2023 to March 2025 on all patients presenting with radiologically confirmed obstructive (non-communicating) hydrocephalus. Permission for undertaking the study was obtained from hospital ethics review committee (vide letter no. ERC/821 dated 6 Mar 2025). Sample size was calculated using the World Health Organization (WHO) sample size calculator, keeping confidence level of 95% and power of study 80%, with incidence of procedure failure in ETV group 6.20% versus 38.00% in VP shunt group.[9] Informed consent was obtained from the parents before including infants in the study. Confidentiality of data obtained was guaranteed using anonymized identification numbers. Using non-probability purposive sampling 100 patients were included in the study. All patients had minimum six months' follow up and complete clinical and imaging documentation available.

Inclusion Criteria: Patients of either gender, who were at least six months old, who presented with radiologically confirmed obstructive hydrocephalus (e.g., aqueductal stenosis, tectal glioma, posterior fossa tumor), with first time CSF diversion procedure (VP shunt or ETV) were included.

Exclusion Criteria: Patients with communicating hydrocephalus (e.g. post infections, post-hemorrhage), prior CSF diversion surgery, syndromic congenital anomalies (e.g. meningomyelocele, Dandy Walker syndrome) were excluded.

Patient data was collected from surgical logs, patient files, radiological records, and follow-up outpatient records. A structured data collection form was used. The study variables included demographic and baseline variables, such as age, gender, residence, socioeconomic status, weight and head circumference. Clinical and radiological variables included etiology of hydrocephalus, imaging modality used, ventricular index, ETV Success Score (if applicable), time from diagnosis to surgery and signs of raised intracranial pressure. Intraoperative variables included type of procedure, duration of surgery, surgeon designation and intraoperative complications. Postoperative outcomes included symptomatic improvement, radiological improvement, complications (infection, malfunction, CSF leak, subdural collection), intensive care need, hospital stay duration, reoperation requirement and time to failure. Follow-up variables included duration of follow-up, functional outcome (e.g., Glasgow Outcome Scale) and any further intervention. Glasgow Outcome Scale (GOS) is used to assess functional outcomes and level of recovery in neurosurgery patients, with scores ranging from 1 to 5 (1 = death, 2 = vegetative state, 3 = severe disability, 4 = moderate recovery, 5 = good recovery). Data collected was analyzed using Statistical Package for Social Sciences (SPSS) version 25.00. Descriptive statistics were documented for demographics. Chi-square test was applied for categorical comparisons (e.g., complication rates), whereas independent sample t-test for continuous variables (e.g., hospital stay) where p-value ≤ 0.05 was considered statistically significant.

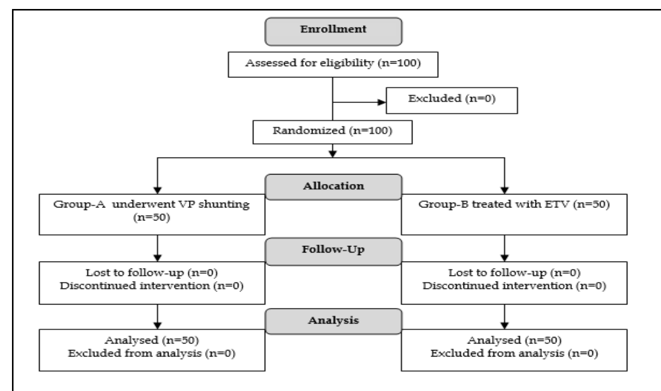

Figure: Patient Flow Diagram (n=100)

RESULTS

A total of 100 patients were included in the study (50 in Group-A and 50 in Group-B). Demographic details are shown in Table-I. Most of the patients belonged to the 2–10-year age group (54.00%), followed by those older than 10 years (36.00%). Females were slightly more in number (54.00%) compared to males (46.00%). A higher proportion of patients came from rural areas (64.00%), indicating limited access to early specialized care. The majority belonged to low and middle socioeconomic backgrounds (34.00% and 36.00%), reflecting a greater burden of disease in these groups.

Table-II presents the indications for surgery among Group-A and Group-B patients. Tectal glioma was the most common indication in both groups, accounting for 36.00% of cases in Group-A and 28.00% in Group-B. Posterior fossa tumors were the second most frequent cause, observed equally in both groups

(28.00%). Aqueductal stenosis contributed to 20.00% of surgeries in Group-A and a slightly higher proportion of 26.00% in Group-B. Congenital hydrocephalus was the least common indication overall, reported in 16.00% of Group-A and 18.00% of Group-B patients. 48 patients required ICU admission while 52 patients did not require ICU admission. On follow up neurological outcomes in terms of Glasgow Outcome Scale (GOS) scores were: GOS 3: 30 patients, GOS 4: 24 patients, GOS 2: 22 patients and GOS 5: 24 patients. No further intervention was required in 68 patients while further intervention was done in 32 patients.

Comparison of outcomes across groups are shown in Table-III. High clinical success rates were found in Group A and Group B (94.00% vs. 96.00%, p = 0.646), but a notably lower re-operation rate in Group B (16.00% vs. 48.00%, p = 0.001) and significantly shorter hospital stays (p<0.001). Complication rates remained lower in Group B (20.00% vs. 36.00%, p = 0.075), although not reaching statistical significance.

Table-I: Demographic Profile of Study Population (n=100)

Variables		n (%)
Age Group Distribution	<2 years	10(10.00%)
	2–10 years	54(54.00%)
	>10 years	36(36.00%)
Gender Distribution	Male	46(46.00%)
	Female	54(54%)
Residence	Rural	64(64.00%)
	Urban	36(36.00%)
Socioeconomic Status	Low	34(34.00%)
	Middle	36(36.00%)
	High	30(30.00%)

Table-II: Indications for Surgery in Group-A and Group-B (n=100)

Indications (Etiology) for Surgery	Group-A (n = 50) n (%)	Group-B (n = 50) n (%)
Tectal Glioma	18(36.00%)	14(28.00%)
Congenital Hydrocephalus	8(16.00%)	9(18.00%)
Posterior Fossa Tumor	14(28.00%)	14(28.00%)
Aqueductal Stenosis	10(20.00%)	13(26.00%)

Table-III: Comparison of Outcomes across Groups in Obstructive Hydrocephalus (n = 100)

Parameter	Group-A (n = 50)	Group-B (n = 50)	p value
Clinical Success n(%)	47(94.00%)	48(96.00%)	0.646
Complications n(%)	18(36.00%)	10(20.00%)	0.075
Reoperation n(%)	24(48.00%)	8(16.00%)	0.001
Average Hospital Stay	8.10 ± 2.426 days	5.42 ± 1.885 days	<0.001

DISCUSSION

Our findings were in accordance with recent studies comparing ETV and VP shunt in obstructive hydrocephalus.[7,8] A meta-analysis of randomized controlled trials has revealed significantly lower postoperative infection rates and CSF leaks with ETV as compared with VP shunt, without significant difference in mortality or success rates.[10] Similarly, a large meta-analysis reported lower complication rates with ETV in idiopathic normal pressure hydrocephalus (iNPH) patients, despite similar effectiveness.[7] In infants or post-infective hydrocephalus, outcomes are more complex. A pediatric meta-analysis showed no significant difference in success rates or complications between ETV and VP shunt, although shunting was associated with a lower risk of CSF leakage.[11] Additional research in infants under two years with aqueductal stenosis suggested higher failure risk with ETV in this subgroup.[12] A very large meta-analysis involving over 13,000 patients indicated ETV had lower infection and shunt-dependency rates, particularly in older children with obstructive hydrocephalus, although VP shunt showed marginally higher success in hemorrhagic etiologies.[13] These findings were in accordance with our observation of comparable success between the two groups, but lower re-operation rate in ETV-treated patients. Our similar clinical success rates in the two groups (p = 0.646) were consistent with literature reporting no significant difference in initial treatment effectiveness between ETV and VP shunt for obstructive hydrocephalus.[10,13] This finding reiterated that when appropriately selected, patients may achieve equally favorable short-term outcomes with either modality. Follow-up GOS scores in our study also supported effective recovery in both groups. Although not statistically significant (p = 0.075), the lower complication rate in the ETV group aligned with studies that highlight fewer infections, device-related issues, and mechanical failures with ETV.[7,10] In a local study, the VP shunt group had a significantly higher rate of surgical site infection and shunt malfunction as compared to ETV.[6] This difference is largely attributed to the absence of implanted hardware in ETV, reducing the risk of infection and foreign body reaction.[8,14] The significant difference in re-operation rate (p = 0.001) highlighted an important advantage of ETV. VP shunts are known to have high revision rates, with some studies reporting failure in up to 50% of cases within the first two years.[15] In contrast, ETV tends to fail early if at all; long-term durability is often superior.16 Our findings confirmed this, with nearly three times fewer re-operations required in the ETV group. We observed significantly shorter hospital stays in the ETV group, a finding consistent with

previous studies. A local study reported mean stay of 3.4 days with ETV vs. 8.1 days with VP shunt.[6] Shorter hospital stays reflect faster recovery, fewer postoperative complications, and reduced ICU needs, all of which contribute to cost-effectiveness and better patient satisfaction.[17] Our findings support the use of ETV as a first-line option for appropriately selected patients with obstructive hydrocephalus. Its lower re-operation rate, shorter hospital stay, and favorable complication profile makes it an attractive alternative to VP shunting.

LIMITATIONS OF STUDY

Our study has several limitations. First, it is non-randomized, introducing potential selection bias. Secondly, the follow-up duration may not be sufficient to capture long-term failures, particularly in ETV cases where late closure of the stoma may occur.[16] Moreover, we did not stratify patients by age, etiology, or previous surgical history, all of which may influence success rates. Future studies should incorporate scoring tools such as the ETV Success Score (ETVSS) 18 to better guide patient selection.

CONCLUSION

ETV provided better results as compared to VP shunt in management of obstructive hydrocephalus in our study in terms of average hospital stay and re-operation rate.

Conflict of Interest: None.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MTM & MA: Data acquisition, data analysis, critical review, approval of the final version to be published.

ZH & AHM: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AR & MU: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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