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Comparison of Endoscopic Third Ventriculostomy and Ventriculo-Peritoneal Shunt in Treating Hydrocephalus in Infants

Muhammad Irshad[1], Choudhary Ali Manzoor[2], Malik Liaqat Ali Jalal[3]

[1,2]Assistant Professor, Associate Professor
Department of Neurosurgery Nishtar Medical University, Multan

Author`s Contribution

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Address of Correspondent
Dr. Muhammad Irshad
Assistant Professor
Department of Neurosurgery Nishtar Medical University, Multan
Iro_dr@yahoo.com

ABSTRACT

Objective: To compare the outcomes of ventriculoperitoneal shunt (VP shunt) versus endoscopic third ventriculostomy (ETV) as surgical interventions in the management of infant hydrocephalus.

Methodology: This randomized controlled trial study was conducted at the Department of Neurosurgery, Nishtar University Hospital, between June 2023 and November 2023. Sixty-two pediatric patients with hydrocephalus, all under two years of age, who underwent cerebrospinal fluid (CSF) diversion through either endoscopic third ventriculostomy (ETV) or ventriculoperitoneal (VP) shunt placement. Patients were divided into two groups using a simple randomization method.

Results: Infection rates were higher in Group VP than in Group ETV, with 5 (16.1%) and 1 (3.2%) cases, respectively (p=0.086). Similarly, obstruction occurred more frequently in Group VP than in Group ETV, with 11 (35.5%) and 9 (29.0%) cases, respectively (p=0.587). However, surgical revisions were performed in 16 (51.6%) cases in Group VP and 13 (41.9%) cases in Group ETV (p=0.445).

Conclusion: These findings suggest that ETV presents as a favorable alternative to VP shunt placement due to its reduced risk of postoperative complications and shorter operative duration, while still maintaining comparable efficacy in terms of preventing obstruction and the necessity for revision surgeries.

Keywords: Complications, ETV, cerebrospinal fluid, Pediatric Hydrocephalus, VP shunt

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Introduction

Hydrocephalus, is the most common neurological disease among pediatric population, exhibits an estimated incidence of congenital cases ranging between 0.5 to 1/ 1000 births, while acquired cases range between 3 to 5 per 1000 births.[1] The CSF is generated by the choroid plexus located within lateral, 3rd, and 4th ventricles, subsequently traversing through subarachnoid spaces before being absorbed via granulations of arachnoid into the systemic circulation and venous sinuses.[2] Hydrocephalus presents with various classifications, notably obstructive versus communicating hydrocephalus, with obstructive types stemming from blockages in CSF flow[3], often attributed to aqueductal stenosis or complications after meningitis, while communicating types involve impaired CSF reabsorption; additional classifications comprise syndromic versus non-syndromic and acquired versus developmental manifestations.[4] Hydrocephalus, a condition characterized by the accumulation of cerebrospinal fluid (CSF) in the brain, is primarily treated through the diversion of CSF.[4]

Various techniques have been developed for this purpose[5], including ventriculo-peritoneal (VP) shunts, ventriculo-atrial (VA) shunts, lumbo-peritoneal shunts, ventriculo-pleural shunts, and endoscopic third ventriculostomy (ETV)[6]. The VP (ventriculoperitoneal) shunt is highly effective in treating hydrocephalus by diverting excess cerebrospinal fluid from the brain's ventricles to the abdominal cavity, thereby relieving intracranial pressure and reducing associated symptoms such as headaches, nausea, and cognitive impairment.[7] Potential disadvantages of VP shunt placement include the risk of infection, mechanical malfunction such as blockage or

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disconnection, over-drainage or under-drainage of cerebrospinal fluid, and the need for periodic monitoring and potential revisions throughout a patient's lifetime.[8] Infections related to VP shunts can lead to serious complications like meningitis or ventriculitis, necessitating prompt medical intervention and sometimes shunt removal. Shunt malfunction can result in symptoms like headaches, nausea, vomiting, and changes in mental status, requiring evaluation and possible surgical correction.[9] Additionally, long-term complications may include abdominal issues such as bowel obstruction or perforation due to the shunt tubing's presence in the peritoneal cavity.[10]

Endoscopic third ventriculostomy (ETV) is an effective alternative for treating hydrocephalus, especially in cases where shunting is not feasible or carries higher risks, as it involves creating a new pathway for cerebrospinal fluid (CSF) drainage using an endoscope to navigate and make a small opening in the third ventricle.[11] However, ETV's effectiveness can be influenced by factors such as patient age, the underlying cause of hydrocephalus, and the surgeon's experience, and potential disadvantages include the risk of complications such as bleeding, infection, and failure of the procedure leading to the need for revision surgery.[12]

ETV and VPS are both established surgical techniques for treating hydrocephalus, but their effectiveness in infants may vary and limited local data from South Punjab region is almost lacking. Previous studies have shown conflicting results regarding the efficacy of these procedures in this specific age group.[13] This study seeks to provide clarity by directly comparing the success rates of ETV and VPS in relieving hydrocephalus symptoms and reducing ICP in infants. The population of this study is drawn from the South Punjab region, with Nishtar Hospital serving as the main medical hub for this area, making it the location of the study.

Methodology

Study was conducted on 62 pediatric patients with hydrocephalus, all under two years of age, who underwent cerebrospinal fluid (CSF) diversion through either endoscopic third ventriculostomy (ETV) or ventriculoperitoneal (VP) shunt placement in a randomized controlled trial. The study took place at the Neurosurgery Department of Nishtar University Hospital between June 2023 and November 2023.

The inclusion criteria for this study are individuals aged between 6 months to 2 years with either congenital hydrocephalus or hydrocephalus after meningitis. Exclusion criteria encompass patients those with secondary hydrocephalus attributed to causes like space occupying lesion, subarachnoid hemorrhage, and intracranial hemorrhage. Baseline investigations including hydrocephalous manifestations and clinical assessment were performed on all patients which include scalp vein dilation, head circumference >98th age percentile, setting sun sign and tense fontanels. Ventricular dilatation was assessed with CT scan, with diagnosing criteria for hydrocephalus including temporal horns width ≥2 mm, FH/ID ratio > 0.5, and ballooning of the frontal horns of lateral ventricles. Additionally, an MRI was conducted to detect malformations any type. A pictorial visualization of intervention floor was given in Figure 1.

In the postoperative assessment of patients with VP shunts, we evaluated their cranial wounds, conscious level, head circumference, abdominal wound, and the pumping function of the reservoir. Furthermore, a CT scan after surgery was performed to evaluate ventricular drainage, proximal limb of the VP shunt, and to check for intra ventricular hemorrhage. MRI imaging was employed to detect even slow flow through the stoma of ETV (Figure 2). Statistical analysis was conducted using SPSS software version 27.0, with a significance level set at a P value above 0.05. Independent sample t test was applied to age and operation time. whereas, chi-square test was applied to check the difference of gender, causes of hydrocephalus

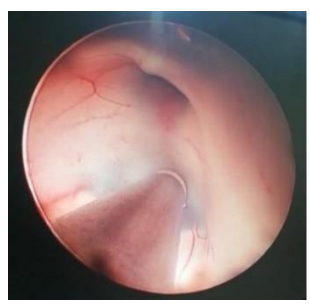

Figure 1. Puncturing floor of 3rd ventricle

Figure 2. ETV Stoma.

etiology, infection Obstruction and revision of surgery with respect to V-P shunt and ETV.

Results

Overall, 62 patients were included in our study. The study patients were equally divided into two groups as VP shunt 31 (50.0%) Group A and ETV 31 (50.0%), Group B. The mean age, gender distribution, case of hydrocephalus etiology and duration of operation of both the groups were almost equal, and the differences were statistically insignificant, (p>0.050). (Table I).

Postoperative outcomes were shown in figure 3. Infection was higher in Group VP than Group ETV as 5 (16.1%) and 1 (3.2%), respectively, (p=0.086). Similarly, obstruction was higher in Group VP than Group ETV as 11 (35.5%) and 9 (29.0%), respectively, (p=0.587). Whereas, surgery was revised 16 (51.6%) in Group VP and 13 (41.9%) in Group ETV, (p=0.445).

Table I: Demographic, causes of hydrocephalus etiology and duration of operation for the study groups.

	V-P shunt Group A 31 (50.0%)	ETV Group B 31 (50.0%)	p-value
Age (years)			
Mean±S.D	13.12±1.78	12.55±1.52	0.173
Gender			
Male	17 (54.8)	20 (64.5)	0.437
Female	14 (45.2)	11 (35.5)	
Cause			
Congenital	13 (41.9)	14 (45.2)	0.798
Postmeningetic	18 (58.1)	17 (54.8)	
Operation time (minutes)			
Mean±S.D	55.81±10.19	57.13±11.56	0.634

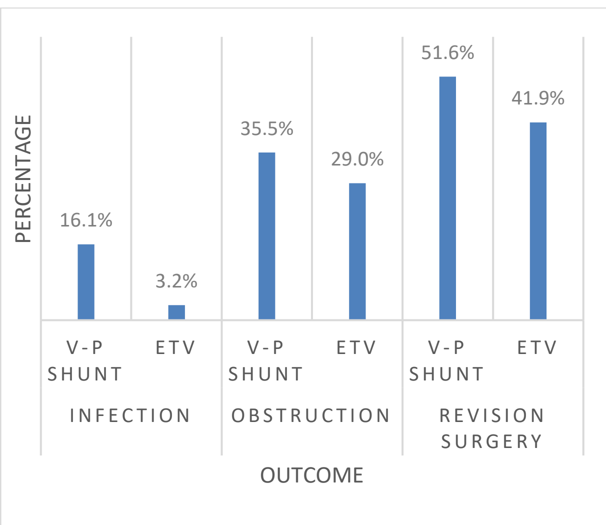

Figure. I. Post-operative outcomes.

Discussion

In this study mean age of patients in group VP was 13.12±1.78 months and in ETV was 12.55±1.52 months. The study conducted by Kulkarni et al[13] reported that the median age of patients in the ventriculoperitoneal (VP) group was 3.1 months, with a range of 2.7 to 3.9 months, while in the endoscopic third ventriculostomy (ETV) group, the median age was also 3.1 months, ranging from 2.2 to 4.2 months. but this difference in age among the groups was insignificant (P=0.173).

In accordance with these study findings a study conducted by Saha et al[14] observed a slight male dominancy in both groups, with males comprising 56.67% and 53.33% in the VP and ETV groups, respectively, compared to females at 53.33% and 46.67% in the VP and ETV groups, respectively. However, the p-value of 0.86 indicated no significant impact on outcomes.

In 2014, a systematic review by Limbrick et al[15] found similar rates of surgical failure between endoscopic third ventriculostomy (ETV) and ventriculoperitoneal (VP) shunt procedures. Similarly, a 2018 meta-analysis by Saekhu et al[16] concluded that neither surgery demonstrated superiority over the other after one year of follow-up.

In Jiang et al[17] 2018 meta-analysis, it was found that ETV demonstrated lower rates of complications, infections, and reoperations, along with shorter durations of surgery and hospital stays compared to VP shunt procedures. However, both treatments showed similar results in terms of symptom improvement, hematoma incidence, and mortality rates. Study conducted by Abdel-Aziz et al[18] found that ETV was associated with lower rates of postoperative infection and shorter operation time compared to VP shunt placement, while observing no significant differences in obstruction rate, or revision surgery between the two procedures.

Ali et al[19] found that in the 4th post-operative week, reoperation was required in 5.9% of patients in the ventriculoperitoneal (VP) group and 2.0% in the endoscopic third ventriculostomy (ETV) group. By the 12th post-operative week, the need for reoperation increased to 17.6% in the VP group but remained at 2.0% in the ETV group. In our study it was 51.6% in VP group and 41.9% in ETV group.

Uche et al[20] conducted a prospective cohort study comparing ETV and VP shunt and reported There was no significant difference observed between the two treatment groups in terms of milestone profile ($p > 0.05$). However, a notable finding was that 13% of ventriculoperitoneal shunt (VPS) patients experienced sepsis, whereas only 4% of endoscopic third ventriculostomy (ETV) patients had this complication ($p < 0.05$). The study also showed that 80% of patients who were shunted became independent from ETV, whereas 92% of ETV patients continued to be shunt-free.

Dewan et al[21] conducted a systematic review focused on children with hydrocephalus after resection of posterior fossa tumor. They reported that postoperative complications were higher following ventriculoperitoneal shunt (VPS) placement (31%) compared to endoscopic third ventriculostomy (ETV) (17%), with a statistically significant p-value of 0.012. The study concluded that while ETV failure occurred sooner than VPS failure, the long-term treatment durability might be higher for ETV in this population.

Drake et al[22] demonstrated that younger infants experience higher rates of surgery failure, potentially due to factors such as thinner skin, immature immune systems, and increased susceptibility to cerebrospinal fluid leakage. Meanwhile, the hazard ratio (HR) for the first failure of children born before 40 weeks gestation during the initial shunt implantation was 2.49 (95% confidence interval [CI] 1.68–3.68), according to Tuli et al.[23], and this risk persisted for future episodes of failure.

Similarly, those aged from 40 weeks gestation to 1 year at the time of the initial surgery also exhibited a significant association with first shunt malfunctions, showing a hazard ratio (HR) of 1.77 (95% CI 1.29–2.44). Lima et al[24] concluded that the effectiveness of ETV is comparable to VP shunt placement in children, as both procedures require subsequent interventions due to shunt failure. In a study conducted in Uganda involving 153 children under one year of age, the success rate of ETV was found to be 53%, with higher success rates of 70% observed in patients with myelomeningocele and aqueductal obstruction.[25]

Limitations: The study not have adequately accounted for confounding variables such as age, etiology of hydrocephalus, comorbidities, or surgeon expertise, which could influence treatment outcomes.

Conclusion

ETV is correlated with shorter operation time and reduced rate of postoperative infection when compared to VP shunt placement. However, there are no significant differences observed in rates of obstruction, and the need for revision surgery between the two procedures. This suggests that ETV presents as a favorable alternative to VP shunt placement due to its reduced risk of postoperative complications and quicker operative duration, while still maintaining comparable efficacy in terms of preventing obstruction, and the necessity for revision surgeries.

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