

## COMPARISON OF COMPLICATIONS OF ENDOSCOPIC THIRD VENTRICULOSTOMY (ETV) VERSUS VENTRICULOPERITONEAL SHUNT AMONG CHILDREN WITH NON-COMMUNICATING HYDROCEPHALUS

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(Received, 15<sup>th</sup> May 2024, Revised 08<sup>th</sup> July 2024, Published 31<sup>st</sup> July 2024)

**Abstract:** The outcome of congenital obstructive hydrocephalus in children, such as surgical complications, neurologic sequelae, and academic achievements, have been the subject of concern in the reported literature. However, much controversy still exists in terms of long-term as well as social outcomes and predictors of various complications and desired clinical outcomes. **Objective:** To compare complications of Endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt among children with non-communicating hydrocephalus. **Methods:** This Quasi-experimental study was conducted at the Department of Neurosurgery, Nishtar Medical University, Multan. Group A patients undergoing Endoscopic third ventriculostomy and Group B patients undergoing Ventriculoperitoneal Shunt (medium pressure Medtronic shunt bur hole type) were taken. Patients were kept in the ward postoperatively until considered fit and discharged on the 5th postoperative day. The first follow-up visit was on the 7th day after discharge; the second follow-up was at one month, and the subsequent follow-up was every three months for one year and shall be recorded on Proforma. **Result:** 54 children with obstructive hydrocephalus were included in our study. Of these, 44 (81.5 %) were male, whereas only 10 (18.5%) were female. The mean age of our study cases was  $12.94 \pm 6.90$  months (range; 6 months to 24 months) and 68. 5%(n=37) were aged up to 15 months. Of these 54 study cases, 46.3% (n=25) were residents of rural areas, while 53.7 % (n = 29) were from urban localities. Twenty-six (48.1%) patients were from poor social class, while 51.9% (n=28) were from middle-income families. Thirty-seven percent (n = 20) of mothers were illiterate, while 63% (n = 34) were literate. Complications were noted in 13 % (n = 7) patients, infection was reported in 3.7% (n= 2), seizures in 9.3% (n=5), and ICH in 3.7% (n=2). These groups, A and B, were comparable in gender, age, residential status, socioeconomic status, and maternal literacy, i.e. (P = 0.293, P = 0.998, P = 0.586, and P = 0.786, P = 0.779, respectively). Complications in group A (ETV) were noted to be 3.7% versus 22.2 % in group B (VP shunt) (P = 0.100). **Conclusion:** Endoscopic third ventriculostomy is a safe, effective, and reliable procedure for the management of congenital obstructive hydrocephalus in the pediatric population as compared with VP shunting. Endoscopic third ventriculostomy surgeries should be a treatment of choice among all treating Neurosurgeons to achieve successful outcomes and a high survival rate.

**Keywords:** Obstructive Hydrocephalus, Endoscopic Third Ventriculostomy, Ventriculoperitoneal Shunt

### Introduction

Hydrocephalus is a hydrodynamic disorder involving the abnormally high collection of cerebrospinal fluid (CSF) in the ventricles and subarachnoid spaces of the brain. Hydrocephalus can be termed as an imbalanced formation of CSF, movement, and absorption of adequate extent to increase fluid within cerebral ventricles (1). The exact prevalence of hydrocephalus in the pediatric population is still unknown. However, it is estimated to be in the range of 1 – 1.5 %, with the incidence of isolated congenital disorder hydrocephalus being 1/1000 live birth (2). Hydrocephalus can be classified into two major categories, based upon its underlying mechanism (3, 4). Non – Communicating hydrocephalus ii). Communicating hydrocephalus. Diagnosis of hydrocephalus is based upon clinical assessment along with radiological testing, which involves CT brain. Ventricle shunt system implementation remains the most commonly used traditional mode of treatment in these patients. However, this procedure is significantly associated with various types of complications in which

infection predominates because of the development of the implant (5). It is estimated more than 40 % of all procedures involving shunt operations may get infected, although neurosurgeons have developed and adapted significant measures in recent decades. Other complications may include postoperative seizures at 25 % and intracranial hemorrhage of more than 3 % (6, 7).

Endoscopic third ventriculostomy (ETV) is a surgical procedure that involves bypassing the aqueduct and CSF pathway of the posterior fossa, and it allows CSF flow from the third ventricle to direct basal cistern and subarachnoid spaces (8). ETV is a minimally invasive procedure and has been reported to be a safe mode of treatment and method of choice for non-communicating hydrocephalus patients, which has lower complication rates when compared with shunt insertion as there is no implant deployed in ETV. Post-ETV intracranial infection rates have been reported to be 8 %, intracranial hemorrhage at 5%, seizures at only 1%, and the failure rate is 30 – 35 % for ETV. Due to these advantages, ETV has gained popularity among

[Citation: Hussain, M.A., Ullah, M.N., Kashif, I., Safdar, S., Ibrahim, M. (2024). Comparison of complications of endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt among children with non-communicating hydrocephalus. *Biol. Clin. Sci. Res. J.*, 2024: 1015. doi: <https://doi.org/10.54112/bcsrj.v2024i1.1015>]

neurosurgeons worldwide as a non-shunting procedure yielding desired outcomes (9-12).

This proposed study will help to ascertain a more effective and safe mode of treatment (ETV versus ventriculoperitoneal shunt) in patients with non-communicating hydrocephalus. The results will help neurosurgeons adapt a more reliable surgical procedure with fewer complications, which will lead to a decrease in disease-related morbidity.

## Methodology

The study was started after the Institutional Ethical Review Board granted permission. Patients having hydrocephalus were registered from the Department of Neurosurgery, Nishtar Medical University, Multan, in this quasi-experimental study using non – probability purposive sampling technique from June 2021 to December 2022 after taking informed written consent from all patients. Hydrocephalus was defined as an enlarged, hypo-dense ventricle having Evan's ratio of more than 0.3, as suggested by CT scan findings).

All male and female patients with congenital obstructive hydrocephalus aged six months to 2 years were included in this study. Patients with associated CNS infections and those with associated congenital anomalies were excluded from our research. The sample size was 54 (27 in each group) (by taking  $p_1 = 40\%$  rate of infection in ventriculoperitoneal shunts and  $p_2 = 8\%$  anticipated proportion of infection in ETV) (12), power of test = 80 %,  $d = 5\%$  at 95 % Confidence level. All the study cases underwent detailed history, clinical examination, and baseline investigations, such as blood tests. Patients were randomly allocated to two groups. Group A patients undergoing Endoscopic third ventriculostomy and Group B patients undergoing Ventriculoperitoneal Shunt (medium pressure Medtronic shunt bur hole type) were taken. Informed consent was obtained from patients, and patients were prepared for general anesthesia, and respective operative procedures were performed per hospital protocols. Patients were kept in the ward postoperatively till considered fit and were discharged on the 5th postoperative day. The first follow-up visit was on the 7th day after discharge; the second follow-up was at one month, and the subsequent follow-up was every three months for one year and shall be recorded on Proforma. Patients were assessed clinically by checking head circumference, palpation of anterior fontanelle, eye gaze, and inquiring about fever, fits, feeding, and crying. CT brain plain was done to see the size of the ventricle, periventricular hypo lucency, the shape of the third ventricle, and differentiation of sulci and gyri compared to the previous CT brain. Based on the clinical and radiological parameters, the procedure's outcome was declared successful after the last follow-up visit.

Data analysis was performed using SPSS version 22; numerical data like patient age was tested for mean and standard deviation, while qualitative data like complications (yes/no), gender, age groups, residential status, and family income was tested by chi-square test. Complications in both groups were compared by applying chi – a chi-square test at the level of significance of 0.05. Confounding variables like gender, age, family income, and residential status were

stratified using a chi-square test (2x2 tables) at 0.05 significance level and 95 %.

## Results

Fifty-four children with obstructive hydrocephalus were included in our study 44 (81.5 %) were male, whereas only 10 (18.5%) were females. The mean age of our study cases was  $12.94 \pm 6.90$  months (range; 6 months to 24 months) and 68. 5%(n=37) were aged up to 15 months. Of these 54 study cases, 46.3% (n=25) were residents of rural areas, while 53.7 % (n = 29) were from urban localities. Twenty-six (48.1%) patients were from poor social class, while 51.9% (n=28) were from middle-income families. Thirty-seven percent (n = 20) of mothers were illiterate, while 63% (n = 34) were literate. Complications were noted in 13 % (n = 7) patients, infection was reported in 3.7% (n= 2), seizures in 9.3% (n=5), and ICH in 3.7% (n=2). These groups, A and B, were comparable in gender, age, residential status, socioeconomic status, and maternal literacy, i.e. ( $P = 0.293$ ,  $P = 0.998$ ,  $P = 0.586$ , and  $P = 0.786$ ,  $P = 0.779$ , respectively). Complications in group A (ETV) were noted to be 3.7% versus 22.2 % in group B (VP shunt) ( $P = 0.100$ ).

**Table 1: Distribution of complications among study cases in both groups. (n = 54)**

Complications (n=54)	Group A		Group B	
	Frequency	%	Frequency	%
<b>Yes</b> <b>n = 07</b> (13.0 %)	01	3.7	06	22.2
<b>No</b> <b>n= 27</b> (87.0 %)	26	96.3	01	77.8
<b>Total</b>	<b>27</b>	<b>100</b>	<b>27</b>	<b>100</b>

**Table 2: Stratification of gender about complications in both groups. (n = 54)**

Gender	Complications	Groups		P – value
		Group A	Group B	
<b>Male</b> <b>(n=44)</b>	Yes (n=06)	01	05	0.198
	No (n=38)	19	19	
<b>Female</b> <b>(n=10)</b>	Yes (n=01)	00	01	0.300
	No (n=09)	07	02	

**Table 3: Stratification of age about complications in both groups. (n = 54)**

Age	Complications	Groups		P – value
		Group A	Group B	
Up to 15 Months (n=37)	<b>Yes</b> (n=06)	01	05	<b>0.180</b>
	<b>No</b> (n=31)	17	14	
More than 15 Months (n=17)	<b>Yes</b> (n=01)	00	01	<b>0.471</b>
	<b>No</b> (n=16)	09	07	

**Table 4: Stratification of residential status with regard to complications in both groups. (n = 54)**

Residential status	Complications	Groups		P – value
		Group A	Group B	
Rural (n=25)	Yes (n=04)	01	03	<b>0.288</b>
	No (n=21)	13	08	
Urban (n=29)	Yes (n=03)	00	03	<b>0.232</b>
	No (n=26)	13	13	

**Table 5: Stratification of socioeconomic status about Complications in both groups. (n = 54)**

Socioeconomic status	Complications	Groups		P – value
		Group A	Group B	
Poor (n=26)	Yes (n=03)	00	03	<b>0.085</b>
	No (n=23)	14	09	
Middle Income	Yes (n=04)			<b>0.600</b>
	No (n=24)	12	12	

## Discussion

Hydrocephalus in children is managed by surgical procedures, which can prove lethal if these patients remain untreated (13). With the advancement of recent surgical techniques and postoperative surgical care, life expectancy has substantially increased; however, mortalities still exist in these patients. There has been an ongoing debate in the available literature regarding the outcomes of different surgical procedures, and controversies still exist (14). This study compared the outcomes of ETV versus VP shunt in terms of complications in children with congenital obstructive hydrocephalus (15).

Fifty-four children with obstructive hydrocephalus were included in our study 44 (81.5 %) were male, whereas only 10 (18.5%) were females. Shoaib et al. also reported 81.66 % male gender with obstructive hydrocephalus (16). Another study conducted in Lahore General Hospital has also reported 70 % male gender in children with hydrocephalus (17). Ha et al. also reported similar trends showing male gender preponderance with 61 % male patients (18). Mari et al. have also reported a 2.5: 1 male-to-female ratio in children with hydrocephalus, similar to our results (19). Junaid et al. also reported 67 % male gender preponderance in children with hydrocephalus, Similar to our results (20). Akram et al. have also reported 67 % male gender predominance in children with hydrocephalus, similar to our results (21).

The mean age of our study cases was  $12.94 \pm 6.90$  months (range; 6 months to 24 months) and 68. 5%(n=37) were aged up to 15 months. Ahmed reported similar results from Lahore General Hospital, with the majority of young children aged less than two years (17). Our results are those of Ha et al. from Peshawar (18). Mari et al. reported that the mean age of children with hydrocephalus was 22.03 months, slightly higher than our results. This difference is due to our inclusion criteria, as we included only patients aged up to 2 years, while Mari et al. had recruited slightly older children as well (19). Of these 54 study cases, 46.3% (n=25) were residents of rural areas, while 53.7 % (n = 29) were from

urban localities. Twenty-six (48.1%) patients were from poor social class, while 51.9% (n=28) were from middle-income families. Thirty-seven percent (n = 20) of mothers were illiterate, while 63% (n = 34) were literate. Ahmed et al. from Lahore General Hospital, Lahore, also reported that 65 % of patients belonged to poor social class, similar to our results (17).

Complications were noted in 13 % (n = 7) patients, infection was reported in 3.7% (n= 2), seizures in 9.3% (n=5), and ICH in 3.7% (n=2). Complications in group A (ETV) were noted to be 3.7% versus 22.2 % in group B (VP shunt) (P = 0.100). Due to such proportions indicating a high burden of complications in shunting procedures, the ETV procedure has gained popularity. Neurosurgeons are now adopting it worldwide to achieve desired clinical outcomes. More than 40 % of all procedures involving shunt operations may get infected, although neurosurgeons have developed and adapted significant measures in recent decades. Other complications may include postoperative seizures at 25 % and intracranial hemorrhage of more than 3 % (22).

Endoscopic third ventriculostomy (ETV) is a surgical procedure that involves bypassing the aqueduct and CSF pathway of the posterior fossa, and it allows CSF flow from the third ventricle to direct basal cistern and subarachnoid spaces. ETV is a minimally invasive procedure and has been reported to be a safe mode of treatment and method of choice for non-communicating hydrocephalus patients, which has lower complication rates when compared with shunt insertion as there is no implant deployed in ETV. Post-ETV intracranial infection rates have been reported to be 8 %, intracranial hemorrhage 5%, and seizures in only 1% (9-12) (George et al. 2005 and Feng et al. 2004), and the failure rate is 30 – 35 % for ETV. Due to these advantages, ETV has gained popularity among neurosurgeons worldwide as a non-shunting procedure yielding desired outcomes (23).

## Conclusion

Endoscopic third ventriculostomy is a safe, effective, and reliable procedure for the management of congenital obstructive hydrocephalus in the pediatric population as compared with VP shunting. The usage of Endoscopic third ventriculostomy surgeries should be a treatment of choice among all treating Neurosurgeons to achieve successful outcomes and high survival rate.

## Declarations

### Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

### Ethics approval and consent to participate

Approved by the department concerned.

### Consent for publication

Approved

### Funding

Not applicable

## Conflict of interest

The authors declared the absence of a conflict of interest.

## Author Contribution

**MUHAMMAD AWAIS HUSSAIN (Registrar)**  
Conception of Study, Development of Research Methodology Design, Study Design, manuscript Review, and final approval of manuscript.

**MARIAM NISSA ULLAH (Medical Officer)**  
Coordination of collaborative efforts.

**IRSHAD KASHIF (Assistant Professor)**  
Study Design, Review of Literature.

**SOHAIL SAFDAR (Principal Research Officer)**  
Conception of Study, Final approval of manuscript.

**MUHAMMAD IBRAHIM (Assistant Professor)**  
Manuscript revisions, critical input.

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[Citation: Hussain, M.A., Ullah, M.N., Kashif, I., Safdar, S., Ibrahim, M. (2024). Comparison of complications of endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt among children with non-communicating hydrocephalus. *Biol. Clin. Sci. Res. J.*, 2024: 1015. doi: <https://doi.org/10.54112/bcsrj.v2024i1.1015>]



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