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Study of endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt (VP shunt) in patients with hydrocephalus at a tertiary hospital

Dr Sushil Shinde[1], Dr Nitin Kotecha[2], Dr Ishtiyaquee Ansari[3], Dr Shanu Patel[4]

[1]Assistant Professor, Department of Emergency Medicine, MGM Medical College & Hospital, Aurangabad, Maharashtra, INDIA.
[2]Consultant Neurosurgeon, MGM Medical College & Hospital, Aurangabad, Maharashtra, INDIA.
Professor, Department of Neurosurgery, MGM Medical College, Aurangabad, Maharashtra, INDIA.
[4]Resident, Department of Neurosurgery, MGM Medical College, Aurangabad, Maharashtra, INDIA.

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Abstract: Background: In children with hydrocephalus, main goal of treatment is to decrease raised ICP, either by ventriculoperitoneal shunt (VPS) or endoscopic third ventriculostomy (ETV). Present study was aimed to compare endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt (VP shunt) in patients with hydrocephalus. **Material and Methods:** Present study was prospective, comparative study, conducted in children of age < 18 years, either gender, undergoing endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt (VP shunt) for symptomatic hydrocephalus. **Results:** In present study, in surgery time was ≤ 48 hours in VPS group (57.14 %) as well as ETV group (71.43 %). Intra-operative complications such as haemorrhage (21.43 % vs 7.14 %) & altered Hemodynamic changes (21.43 % vs 7.14 %) common in VPS group as compared ETV group, difference was statistically significant. Post-operative complications were common in VPS group such as hematoma (21.43 %), infection (7.14 %), CSF leak (7.14 %) & shunt obstruction (7.14 %) as compared to ETV group such as hematoma (7.14 %) & subdural hygroma (7.14 %), difference was statistically significant. Successful outcome was noted in VPS group (57.14 %) as well as ETV group (71.43 %), difference was not significant statistically. Sequalae of hydrocephalus were observed more in VPS group (21.43 %) as compared to ETV group (7.14 %), difference was not significant statistically. Mortality outcome was noted in VPS group (7.14 %) as well as ETV group (7.14 %). **Conclusion:** Endoscopic third ventriculostomy (ETV) had less operative complications than ventriculoperitoneal shunt (VP shunt) in patients with hydrocephalus but there were no significant difference between the outcomes of ETV and VPS insertion.

Keywords: Endoscopic third ventriculostomy (ETV), ventriculoperitoneal shunt (VP shunt), hydrocephalus, aqueductal stenosis

Corresponding Author: Dr Nitin Kotecha, Consultant & Head of Neurosurgery, Sai Neurocity Hospital, Aurangabad, Maharashtra, INDIA.
Email: drnitin.kotecha@gmail.com

INTRODUCTION

Hydrocephalus is characterized by excessive accumulation of cerebrospinal fluid (CSF), leading to ventricular dilatation, raised intracranial pressure and may be accompanied by secondary brain parenchymal atrophy.[1] Hydrocephalus is one of the commonest complications of tuberculous meningitis, including noncommunicating, communicating, and combinations of obstruction in addition to defective absorption of cerebrospinal fluid.[2]

The main goal of treatment is to decrease raised ICP, either by ventriculoperitoneal shunt (VPS) or endoscopic third ventriculostomy (ETV).[3] Endoscopic third ventriculostomy (ETV) and ventriculoperitoneal shunt (VPS) are two surgical methods used for the treatment of obstructive hydrocephalus to create an alternative pathway for CSF to flow out of the ventricles and around the brain (ETV) or in the peritoneum (VPS).[4]

Despite the advances that have been achieved recently in the field of neuroendoscopy and shunt hardware, the treatment of hydrocephalus in infants remains one of the most difficult and challenging situations faced by neurosurgeons. Shunts have been used for long to divert CSF in patients with hydrocephalus whether obstructive or communicating. Ventriculoperitoneal shunt (VPS) placement is the standard of care for patients with communicating hydrocephalus, but the procedure has a high failure rate—up to 40% fail within 1 year and 50% fail within 2 years.[5,6] Present study was aimed to compare endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt (VP shunt) in patients with hydrocephalus.

MATERIAL AND METHODS

Present study was prospective, comparative study, conducted in Department of Neurosurgery, MGM Medical College, Aurangabad, India. Study duration was of 2 years (January 2021 to December 2022). Study approval was obtained from institutional ethical committee.

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Inclusion criteria

Children of age < 18 years, either gender, undergoing endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt (VP shunt) for symptomatic hydrocephalus, parents willing to participate in present study

Exclusion criteria

Patients with tumors pending surgical excision and those with any co-morbidity affecting cognitive function were excluded.

Study was explained to parents of children in local language & written consent was taken for participation & study. After enrolment in the study, demographic details, history, clinical examination findings, radiological & laboratory investigations were noted in case record proforma. After fitness, patients were randomized into two groups using based on computer-generated random numbers and planned for respective CSF diversion procedures.

In all ETV procedures, ventricles were accessed through a precoronal burr hole in the midpupillary line using a rigid Gaab Neuroendoscope (Karl Storz, Germany). Lateral angle of the open anterior fontanelle was used as an entry point in small children. Third ventriculostomy was performed with the aid of a 3 or 4 Fr Fogarty balloon catheter and bipolar cautery.

The standard VP shunt procedure was performed through a parietal burr hole using Chhabra VP shunt (G. Surgiwear Ltd., Uttar Pradesh, India). Type of shunt (either low pressure or medium pressure) used was based on opening flow of CSF on ventricular catheterization.

All patients received antiepileptics, glucocorticoids, and antibiotics as per standard operating procedure.

Intra-operative details, complications (intra-operative, post-operative), outcome were noted. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.05 was considered as statistically significant.

RESULTS

In present study, 14 children each underwent endoscopic third ventriculostomy (ETV) & ventriculoperitoneal shunt (VPS) procedure for hydrocephalus. In ventriculoperitoneal shunt (VPS) majority of children were from 11-18 years age group (57.14 %) while in endoscopic third ventriculostomy (ETV) majority were from less than 5 years age group (64.29 %). Majority were male in VPS group (57.14 %) as well as ETV group (71.43 %). Common etiology in VPS group was tumour (35.71 %) & aqueductal stenosis (14.29 %) while in ETV group was aqueductal stenosis (50 %). Focal Neurological Deficits were noted in majority of VPS group (50 %) as compared to ETV group (35.71 %). According to CT scan & MRI findings, common etiology was acquired (57.14 %) followed by congenital (21.43 %) & tuberculoma (21.43 %). In ETV group, according to CT scan & MRI findings common etiology was congenital (64.29 %) & acquired (35.71 %).

Table 1- General characteristics

Characteristics	Ventriculoperitoneal shunt (VPS)	Endoscopic third ventriculostomy (ETV)	p value
Age groups (in years)			0.62
<1 year	3 (21.43 %)	6 (42.86 %)	
01-05	3 (21.43 %)	3 (21.43 %)	
06-10	0	2 (14.29 %)	
11-18	8 (57.14 %)	3 (21.43 %)	
Gender			0.69
Male	8 (57.14 %)	10 (71.43 %)	
Female	6 (42.86 %)	4 (28.57 %)	
Etiology			0.56
Aqueductal stenosis	2 (14.29 %)	7 (50 %)	
Tumour	5 (35.71 %)	1 (7.14 %)	
Infection	2 (14.29 %)	2 (14.29 %)	
Meningitis	2 (14.29 %)	0	
Idiopathic	1 (7.14 %)	0	
Other cerebral and spinal malformations	1 (7.14 %)	2 (14.29 %)	
Atresia of foramen of Monro	1 (7.14 %)	0	
Arachnoid cyst	0	1 (7.14 %)	
Posterior fossa cyst	0	1 (7.14 %)	
Focal Neurological Deficit			0.53
Present	7 (50 %)	5 (35.71 %)	
Absent	7 (50 %)	9 (64.29 %)	
CT & MRI findings			0.62
Acquired	8 (57.14 %)	5 (35.71 %)	
Congenital	3 (21.43 %)	9 (64.29 %)	
Tuberculoma	3 (21.43 %)	0	

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In present study, in surgery time was ≤ 48 hours in VPS group (57.14 %) as well as ETV group (71.43 %). Intra-operative complications such as haemorrhage (21.43 % vs 7.14 %) & altered Hemodynamic changes (21.43 % vs 7.14 %) common in VPS group as compared ETV group, difference was statistically significant. Post-operative complications were common in VPS group such as hematoma (21.43 %), infection (7.14 %), CSF leak (7.14 %) & shunt obstruction (7.14 %) as compared to ETV group such as hematoma (7.14 %) & subdural hygroma (7.14 %), difference was statistically significant.

Table 2- Surgery characteristics

Characteristics	Ventriculoperitoneal shunt (VPS)	Endoscopic third ventriculostomy (ETV)	p value
Surgery time (hours)			0.55
> 48	6 (42.86 %)	4 (28.57 %)	
≤ 48	8 (57.14 %)	10 (71.43 %)	
Intra Operative complications			0.043
Haemorrhage	3 (21.43 %)	1 (7.14 %)	
Hemodynamic changes present	3 (21.43 %)	1 (7.14 %)	
Post OP complications			0.038
Hematoma	3 (21.43 %)	1 (7.14 %)	
Infection	1 (7.14 %)		
CSF Leak	1 (7.14 %)		
Shunt Obstruction	1 (7.14 %)		
Subdural Hygroma		1 (7.14 %)	

In present study, successful outcome was noted in VPS group (57.14 %) as well as ETV group (71.43 %), difference was not significant statistically. Sequalae of hydrocephalus were observed more in VPS group (21.43 %) as compared to ETV group (7.14 %), difference was not significant statistically. Mortality outcome was noted in VPS group (7.14 %) as well as ETV group (7.14 %).

Table 3 - Outcome

Characteristics	Ventriculoperitoneal shunt (VPS)	Endoscopic third ventriculostomy (ETV)	p value
Success			0.52
Successful	8 (57.14 %)	10 (71.43 %)	
Failed	6 (42.86 %)	4 (28.57 %)	
Outcome			0.63
Recovery	10 (71.43 %)	12 (85.71 %)	
Sequalae	3 (21.43 %)	1 (7.14 %)	
Mortality	1 (7.14 %)	1 (7.14 %)	

DISCUSSION

Hydrocephalus is characterized by excessive accumulation of cerebrospinal fluid (CSF), leading to ventricular dilatation, raised intracranial pressure and may be accompanied by secondary brain parenchymal atrophy.[1]

The treatment of different types of hydrocephalus including communicating and non-communicating hydrocephalus has traditionally been through the insertion of a shunting device, usually a V-P or ventriculoatrial shunt. The development of neuroimaging and less invasive surgeries have changed the treatment of hydrocephalus. Nowadays, ETV is a good choice for the treatment of obstructive/ noncommunicating hydrocephalus with success rates of up to 90% in cases of aqueductal stenosis.[7,8]

In study by Aranha A et al.[9], 26 patients underwent ETV with a success rate of 65.4% with six of nine failures occurring within the first 16 days after surgery (median time to failure – 3 days). In the VP shunt group, there was a success rate of 61.54% and a median time to failure of 50 days. Modified Vellore grading was found to be a significant factor in determining outcome in both ETV and VP shunt groups with high-grade TBM consistently associated with poor outcome (odds ratio = 4.2).

Abhaya V. Kulkarni et al.,[10] reported that ETV success was 66.3% at 6 months and 64.1% at 36 months, while shunt success was 87.8 % at 6 months and 79.1 % at 36 months. These initial results suggest that shunting has a superior success rate compared to ETV, although the success rate for both was relatively high. Pawan Goyal et al.,[11] found 68% of success rate in cases underwent VP shunt and 42% success rate among ETV group and there is no significant difference in success rate.

El Damaty A et al.,[12] studied 70 patients. ETV success rate was 41.4%. The highest rate was in tumor-related hydrocephalus and fourth ventricle outlet obstruction (62.5%, 60%) and the lowest rate was in Chiari-type II and following infection (16.7%, 0%). The below 3 months age group showed relatively lower success rate (33.3%) in comparison to older groups which showed similar results (46.4%, 46.6%). Statistically, a previous VP shunt was a predictor for failure (p value < 0.05).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

Studies have shown that in patients under 19 years of age suffering from hydrocephalus related to a Posterior Fossa Brain Tumor (PFBT), the cumulative failure rate was 21% and 29% in ETV and VPS operation, respectively. At first, the ETV survival curve shows a sharp decrease and after two months it gets fixed while VPS curve makes a gradual decrease and reaches to a level lower than ETV curve after 5.7 months. Post-operative complications in ETV and VPS methods are 17% and 31%, respectively. In infants younger than 12 months with hydrocephalus due to congenital Aqueduct Stenosis (AS), and also in the elderly patients suffering from Normal Pressure Hydrocephalus (NPH), ETV is a better treatment option.[13]

In a systematic review and meta-analysis, Jesuyajolu DA et al,[14] noted that there was no statistically significant difference between the outcomes of ETV and VPS (OR- 0.27; 95% CI −0.39–0.94, P = 0.42). After reviewing the rates of complications of ETV and VPS from the identified studies, four were recurrent. The infection rates of ETV versus VPS were 0.02% versus 0.1%. The mortality rates were 0.01% versus 0.05%. The reoperation rates were 0.05% versus 0.3%, while the rates of ETV failure and shunt malfunction were 0.2% versus 0.2%. They noted that there was no significant difference between the outcomes of ETV and VPS insertion.

In a meta-analysis Lin Jiang et al., provided robust evidence that ETV has greater benefits in terms of major complications, infection, reoperation, duration of surgery, and hospital stay than VS for patients with noncommunicating hydrocephalus.

Heshmati B et al.,[16] studied endoscopic third ventriculostomy in children with failed ventriculoperitoneal shunt. Most common causes of hydrocephalus in these patients were aqueductal stenosis and myelomeningocele with or without associated shunt infection. Of these 33 cases, 20 ETV procedures were successful, and 13 cases needed shunt revision after ETV failure. There was no serious complication during ETV procedures. The follow-up period of patients with successful ETV was 6–50 months (mean 18 months). The time interval between ETV and new shunting subsequent to ETV failure was 24.4 days (10–95). ETV can be considered as an alternative treatment paradigm in patients with previous shunt or new shunt failure with an acceptable success rate of 6o%, although long-term follow-up is needed for these patients.

ETV involves the creation of a new CSF pathway. This permits the third ventricle to communicate with the CSF spaces surrounding the brain stem. It avoids the risk of hardware infection, colonization, and malfunction associated with shunts, especially useful in low-resource settings.[17] Endoscopic third ventriculostomy (ETV) is inherently superior to the shunt in the treatment of hydrocephalus, circumventing the need for insertion of a foreign body, and avoiding shunt-related morbidity.[18]

CONCLUSION

Endoscopic third ventriculostomy (ETV) had less operative complications than ventriculoperitoneal shunt (VP shunt) in patients with hydrocephalus but there were no significant difference between the outcomes of ETV and VPS insertion. However, more extensive studies with a larger sample size are required to compare endoscopic third ventriculostomy (ETV) versus ventriculoperitoneal shunt (VP shunt) in patients with hydrocephalus in various etiologies.

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