Endoscopic Third Ventriculostomy for Hydrocephalus in Pediatrics

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Significance: There is an inverse relation between the extent of postoperative decrease in ventricular size to duration and magnitude of preoperative symptoms. On the other hand, decrease in size of ventricles after ETV may or may not indicate a successful process as it has been established to lessen marginally in both setting. The clinical findings of patients underwent endoscopic third ventriculostomy (ETV) for hydrocephalus were studied and compared in our study to make decisions more clear.

Abstract

Background: Abnormal CSF accumulation within ventricles of brain leading to raised intracranial pressure is a potentially life-threatening state that is commonly seen in neurosurgical patients. Aim of this study is to assess the efficacy of endoscopic third ventriculostomy (ETV) in treatment of pediatric hydrocephalus in pediatrics.

Materials and Methods: A total of sixty-two patients were included in this prospective study. Patients were generally discharged from the hospital on the 2nd or 3rd postoperative day unless some complication arose. All the information was recorded in a pre-structured proforma, and data were analyzed by SPSS. Statistical significance was defined as p-value less than or equal to 0.05.

Results: At follow up, clinical improvement and radiological findings did not necessarily correlate with each other, as ventricular size was reduced in only 42 (67.7%) out of 62 patients. Remaining 20 (32.3%) patients had no change in the size of ventricles. The difference was not statistically significant. However, as observed by cine PC MRI, CSF flow was observed in all the patients.

Conclusion: In non-communicating hydrocephalus, ETV is a simple technique and safe and effective treatment if done by an expert surgeon correctly. It is a reasonable alternate of VPS due to its simplicity and effectiveness.

Introduction

A urologist named Mixter, first executed endoscopic third ventriculostomy (ETV) successfully in Chicago 1923 (1). While in hydrocephalus cases, the most widespread procedure to be used is ventriculoperitoneal shunt (VPS). There is 80% long-term shunt failure in patients during a period of 20 years going from childhood to adulthood (2). In contrast to this, the best alternate technique to the cerebrospinal fluid (CSF) shunt systems for treating hydrocephalus triventricular is endoscopic third ventriculostomy (ETV). ETV is intended for communication between third ventricle and interpeduncular cistern is to create CSF flow which bypasses an obstruction to allow circulation of CSF (3). Abnormal CSF accumulation within ventricles of brain leading to raised intracranial pressure is a potentially life-threatening state that is commonly seen in neurosurgical patients. On the basis of presence or absence of the obstruction of CSF outflow it is divided into communicating or non-communicating hydrocephalus (4). Ventriculoperitoneal shunt is economical and easily available device which is remains mainstay of treatment even today. On the other hand, shunt failure is common and repetitions in use may not give outcomes (5). Due to this reason endoscopic procedures such as endoscopic third ventriculostomy, endoscopic aqueductoplasty, and endoscopic aqueductal stenting are gaining recognition than VP shunt. Success of ETV is defined on the basis of clinical and radiological conditions. Clinical criteria comprise of resolution of signs of increased intracranial pressure such as improved consciousness, ocular movement abnormalities and headache and reduction in the circumference of head and in the fontanelle tension in infants. While radiological criteria comprise 25% and 15% decrease in size of third ventricle within 3 months of follow up and in size of the third ventricle within 1 month respectively is considered as a reliable indication of favorable outcome (6, 7). There is an inverse relation between the extent of postoperative decrease in ventricular size to duration and magnitude of preoperative symptoms on the other hand decrease in size of ventricles after ETV may or may not indicate a successful process as it has been established to lessen marginally in both setting (8). The clinical findings of patients underwent endoscopic third ventriculostomy (ETV) for hydrocephalus were studied and compared in our study. The objective is to assess the efficacy os ETV in treatment of pediatric hydrocephalus.

Materials and Methods

It is a prospective study done during 3 years from June 2017 to May 2020, in Nishtar Hospital Multan in Department of Neurosurgery. Ethical approval was obtained from the ethical board of the hospital. Sample size was calculated using the reference study by Sarmast et al. (9). Nonprobability consecutive type of sampling technique was used. Patient's personal data including age, sex, and other factors such as causes, signs and symptoms of the disease as well as previous use of any device or shunt, imaging findings including Evans ratio, and intraoperative and postoperative complications were recorded for this study. Participants of this study included only those patients who had age between 6 months to 18 years and symptoms for intracranial hypertension and radiographic evidence indicating of non-communicating hydrocephalus. The Burr hole was used surgical technique in this study that was placed anterior to the coronal suture in the right prefrontal area in the mid-pupillary line. The burr hole is used to achieve the optimal trajectory into the 3rd ventricle via foramen of Monro and interpeduncular cistern. Through video guidance, 0° rigid endoscope with double irrigating sheath (4.6mm) would be introduced into the lateral ventricle by following the catheter. In the supine position burr hole was at highest when head was flexed, ETV was performed. Identification of the foramen of Monro could be done by joining together of thalamostriate vein, septal vein, and choroid plexuses. For irrigation, Ringer's lactate is used at 90°F temperature. Negotiating endoscope via foramen Monro was used for perforation in 3rd ventricle and cautery probe between mammillary bodies and infundibular recess used for puncturing at most transparent site. Inflating Fogarty catheter was used for dilating an initial fenestration. At the end of the procedure Gelfom plug was introduced in the cortical tract.

Postoperative follow-up Patients were generally discharged from the hospital on the 2nd or 3rd postoperative day unless some complication arose. All the information was recorded in a pre-structured proforma, and data were analyzed by. Statistical significance was defined as P value less than or equal to 0.05.

If no complications occur patients were discharged from hospital after surgery in 2 to 3 days. Follow up was done postoperatively, after duration of 2 weeks, 1, 3, and 6 months and each 6 months subsequently. Imaging via magnetic resonance imaging (MRI) or computed tomography (CT) scan was done in the patients if the aspects showed failed ETV done before 3 months. On the other hand, 3 months follow up for MRI or CT scan of brain was done to see ventricular size postoperatively. The patency of the stoma was determined by Cine phase-contrast MRI which is done in all the patients. Flow across stoma was not considered s a sign of stoma closure. If there was no shunt insertion and decrease in symptoms of intracranial pressure (irritability and vomiting, resolution of eye findings as sixth cranial nerve palsy, and a reduction in ventriculomegaly as determined on ultrasonography or MRI/CT scanning using Evans index or fronto-occipital horn ratio and also demonstration of CSF flow on cine PC MR), the procedure was considered to be successful. Pre-structured performa was used to record information and for statistical analysis Statistical Package for Social Sciences (SPSS) version 23 was used. $P \leq 0.05$ was statistical significance.

Results:

Clinical Presentation: Out of 62 patients, clinical presentation was headache in 29 patients; increased head circumference in 10 patients; gait disturbance in 7 patients; hemiparesis in 4 patients; bulging fontanelle in 3 patients; nausea and vomiting, altered mental status, urinary incontinence, and Parinaud's syndrome in 2 patients each; and locomotor ataxia in one patient. This information is shown in Table 1.

Table 1: Clinical presentation of the patients

Clinical Presentation	**N**
Headache	29
Increased head circumference	10
Gait disturbance	7
Hemiparesis	4
Bulging fontanelle	3
Nausea and vomiting	2
Altered mental status	2
Urinary incontinence	2
Parinaud's syndrome	2
Locomotor ataxia	1

Outcomes and Complications: Posterior fossa mass was present in 13 patients and successful ETV was performed in all, with stomal block was observed as a complication in one patient. Primary aqueduct stenosis was present in 11 patients and successful ETV was performed in all, with CSF leak was observed as a complication in one patient. Myelomeningocele associated hydrocephalus was present in 12 patients and successful ETV was performed in 11 patients, out of which one patient presented with stomal block. Hydrocephalus due to previous VPS failure was present in 9 patients and ETV was successful in 8 patients, of which 2 patients later on presented with stomal block. Posterior third ventricular mass was the cause of hydrocephalus in 6 patients, and all went through successful ETV and one patient developed CSF leak. Dandy-Walker syndrome was the etiology in 11 patients and successful ETV was performed in all of them; and no patient developed any complication. Total 6 patients developed any type of complication. Table 2.

Table 2: Etiology, procedure success, outcome, and complications			
Etiology	Procedure success	Outcome	Complications
Posterior fossa mass (13)	13/13	12/13	1, stomal block
Primary aqueduct stenosis (11)	11/11	10/11	1, CSF leak
Myelomeningocele associated (12)	11/12	10/11	1, stomal block
Previous VPS failure (9)	8/9	6/8	2, stomal block
Posterior third ventricular mass (6)	6/6	5/6	1, CSF leak
Dandy-Walker syndrome (11)	11/11	11/11	-
Total	60/62	54/60	6 complications

Effectiveness:

At follow up, clinical improvement and radiological findings did not necessarily correlate with each other, as ventricular size was reduced in only 42 (67.7%) out of 62 patients. Remaining 20 (32.3%) patients had no change in the size of ventricles. The difference was not statistically significant. However, as observed by cine PC MRI, CSF flow was observed in all the patients. Table 3.

Table 3: Effectiveness of ETV in non-communicating hydrocephalus			
Etiology	Reduced ventricular diameter	Unchanged ventricular diameter	P value
Posterior fossa mass (13)	6	7	0.284
Primary aqueduct stenosis (11)	10	1	
Myelomeningocele associated (12)	8	4	
Previous VPS failure (9)	6	3	
Posterior third ventricular mass (6)	5	1	
Dandy-Walker syndrome(11)	7	4	
Total (62)	42 (67.7%)	20 (32.3%)	

Discussion

The common practice of ETV is due to its success in terms of avoidance of dependency on VPS for life and a guaranteed shunt free period. In cases where VPS or VASs are not successful, ETV presents itself as a reasonable alternate. In a comparison between VPS/VAS and ETV the safety and better treatment approach for pediatrics is the main issue relating to use of ETV in hydrocephalus (10). However there is variety of views on ETV being an effective approach in children with age less than 1 year [11] and question of ETV treatment failure risks in the infants and young children than older children is still under discussion by many authors. Along with the age of patient, the causes of the hydrocephalus are also considered as evidence of success of ETV (12). In a study by Cinalli et al. (13) it was reported that patients with age less than 6 months in which ETV was considered to be a contraindication, is now performed successfully.

In another study done by Gorayeb et al. (14) the success rate for ETV performed in young children with age less than 1 year suffering from obstructive hydrocephalus was 64% and it was concluded that ETV can be used when ever required regardless of the age of children younger than 1 year. As in previous studies, failure in use of ETV was reported in patients younger than six months (15), our study included patients above age of 6 months. There was success rate of 71% for ETV approach of treatment in patients with obstructive hydrocephalus along with VPS obstruction as well as only 25% showed no recurrence after 2 years of follow-up, according to the study of Woodworth et al (16).

Age of patients younger than 1 year, already present shunt infection, and infection occurred after shunt placement; have been attributed to factors leading to failure of this procedure (17). But in our study there was no statistically significant correlation between both age of patients and causes of hydrocephalus with ETV failure ($P > 0.05$). The reason to these findings may relate to limited size of sample along with lesser rate of complications in our study.

Damage in the pituitary stalk and hypothalamic, that majorly occurs in the diabetes insipidus, were the complication not encountered in our study and were described by other authors (18). Other complications included were cardiac arrhythmias and respiratory arrest due to hypothalamic irritation and manipulation, (19) damage to vascular structure (most feared complication of all) such as basilar artery due to the proximity in the perforation field. Any fenestration in the floor of the 3rd ventricle made with potassium titanyl phosphate laser even slight perforations due to endoscope or Fogarty balloon may cause occurrence of basilar artery injury. If the floor is not transparent intravenous ICG dye to visualize the basilar artery through the opaque third ventricular floor (20) and microvascular Doppler probes have been used for identification of artery in order to avoid this complication.

Conclusion

In non-communicating hydrocephalus, ETV is a simple technique and safe and effective treatment if done by an expert surgeon correctly. It is a reasonable alternate of VPS due to its simplicity and effectiveness. In comparison to post shunt the radiological improvements after ETV approach are less because the size of ventricles does not decrease and the fluid is maintained in the same physiological space, that occur in patients with shunt placement. The results of ETV in shunt malfunction patients are encouraging and this proves that patients can stay. Rate of complications and side effects of ETV are limited generally.

Conflict of interest: Authors do not have any conflict of interest to declare.

Disclosure: None

Human/Animal Rights: No human or animal rights are violated during this study.

References

1. Mixter WJ. Ventriculocopy and puncture of the floor of the third ventricle. Boston Med J 1923;188:277-8. *DOI: 10.1056/NEJM192303011880909*
2. Paulsen AH, Lundar T, Lindegaard KF. Twenty-year outcome in young adults with childhood hydrocephalus: Assessment of surgical outcome, work participation, and health-related quality of life. J Neurosurg Pediatr 2010;6:527-35. *doi: 10.3171/2010.9.PEDS09548.*
3. Feng H, Huang G, Liao X, Fu K, Tan H, Pu H, et al. Endoscopic third ventriculostomy in the management of obstructive hydrocephalus: An outcome analysis. J Neurosurg 2004;100:626-33. *doi: 10.3171/jns.2004.100.4.0626.*
4. Yadav YR, Parihar V, Pande S, Namdev H, Agarwal M. Endoscopic third ventriculostomy. J Neurosci Rural Pract. 2012;3(2):163-73. *doi: 10.4103/0976-3147.98222*
5. Dusick JR, McArthur DL, Bergsneider M. Success and complication rates of endoscopic third ventriculostomy for adults hydrocephalus: a series of 108 patients. Surg Neurol. 2008;69:5-15. *doi: 10.1016/j.surneu.2007.08.024.*
6. Jernigan SC, Berry JG, Graham DA, Goumnerova L. The comparative effectiveness of ventricular shunt placement versus endoscopic third ventriculostomy for initial treatment of hydrocephalus in infants. J Neurosurg Pediatr. 2014;13:295-300. *doi: 10.3171/2013.11.PEDS13138.*
7. Santamarta D, Martin-Vallejo J, Díaz-Alvarez A, Maillo A. Changes in ventricular size after endoscopic third ventriculostomy. Acta Neurochir (Wien). 2008;150:119-27. *doi: 10.3171/2012.9.PEDS12243.*
8. Schwartz TH, Yoon SS, Cutruzzola FW, Goodman RR. Third ventriculostomy: post-operative ventricular size and outcome. Minim Invasive Neurosurg. 1996;39:122-9. *doi: 10.1055/s-2008-1052231.*
9. Sarmast A, Khursheed N, Ramzan A, Shaheen F, Wani A, Singh S, Ali Z, Dar B. Endoscopic third ventriculostomy in noncommunicating hydrocephalus: report on a short series of 53 children. Asian journal of neurosurgery. 2019 Jan;14(1):35. *doi: 10.4103/ajns.AJNS_187_16*
10. Reddy GK, Bollam P, Caldito G, Guthikonda B, Nanda A. Ventriculoperitoneal shunt surgery outcome in adult transition patients with pediatric-onset hydrocephalus. Neurosurgery 2012;70:380-8. *doi: 10.1227/NEU.0b013e318231d551.*
11. de Resende MA, da Silva EV, Nascimento OJ, Gemal AE, Quintanilha G, Vasconcelos EM. Total intravenous anesthesia (TIVA) in an infant with Werdnig-Hoffmann disease. Case report. Rev Bras Anestesiol 2010;60:170-5. *doi.org/10.1590/S0034-70942010000500014.*
12. Balthasar AJ, Kort H, Cornips EM, Beuls EA, Weber JW, Vles JS. Analysis of the success and failure of endoscopic third ventriculostomy in infants less than 1 year of age. Childs Nerv Syst 2007;23:151-5. *doi: 10.1007/s00381-006-0219-z.*
13. Cinalli G, Sainte-Rose C, Chumas P, Zerah M, Brunelle F, Lot G, et al. Failure of third ventriculostomy in the treatment of aqueductal stenosis in children. J Neurosurg 1999;90:448-54. *doi: 10.3171/jns.1999.90.3.0448.*
14. Gorayeb RP, Cavalheiro S, Zymberg ST. Endoscopic third ventriculostomy in children younger than 1 year of age. J Neurosurg 2004;100 5 Suppl Pediatrics: 427-9. *doi: 10.3171/ped.2004.100.5.0427.*
15. Leach P, Thorne J, Palmer J. Response to: Ten years of experience with paediatric neuroendoscopic third ventriculostomy features and perioperative complications of 210 cases. J Neurosurg Anesthesiol 2005;17:172. *https://pubmed.ncbi.nlm.nih.gov/15632540/*
16. Woodworth G, McGirt MJ, Thomas G, Williams MA, Rigamonti D. Prior CSF shunting increases the risk of endoscopic third ventriculostomy failure in the treatment of obstructive hydrocephalus in adults. Neurol Res 2007;29:27-31. *doi: 10.1179/016164106X119914.*
17. Koch-Wiewrodt D, Wagner W. Success and failure of endoscopic third ventriculostomy in young infants: Are there different age distributions? Childs Nerv Syst 2006;22:1537-41. *doi: 10.1007/s00381-006-0191-7.*
18. Di Roio C, Mottolese C, Cayrel V, Berlier P, Artru F. Ventriculostomy of the third ventricle and diabetes insipidus. Ann Fr Anesth Reanim 1999;18:776-8. *doi: 10.1016/s0750-7658(00)88456-7.*
19. Anandh B, Madhusudan Reddy KR, Mohanty A, Umamaheswara Rao GS, Chandramouli BA. Intraoperative bradycardia and postoperative hyperkalemia in patients undergoing endoscopic third ventriculostomy. Minim Invasive Neurosurg 2002;45:154-7. *doi: 10.1055/s-2002-34339.*
20. Wachter D, Behm T, von Eckardstein K, Rohde V. Indocyanine green angiography in endoscopic third ventriculostomy. Neurosurgery 2013;73 1 Suppl Operative: ons67-72; ons72-3. *doi: 10.1227/NEU.0b013e318285b846.*