International Journal of Medical Arts 2020; 2 [3]: 567-571.

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main subject [Surgery [Neurosurgery]] *

Original article

Our Experience with The Treatment of Hydrocephalus in Infants: Endoscopic Third Ventriculostomy versus Ventriculo-Peritoneal Shunt: A retrospective Comparative Study

Mohammed El-Gebaly Ahmed Alhady; Mohamed Youssef

Department of Neurosurgery, Damietta Faculty of Medicine, Al-Azhar University, Egypt.

Corresponding author
Mohammed El-Gebaly Ahmed Alhady
Email: m.gebali@domazhermedicine.edu.eg

Received at: April 27, 2020; Revised at: July 04, 2020; Accepted at: July 06, 2020; Available online at: July 06, 2020

DOI: 10.21608/ijma.2020.28849.1121

ABSTRACT

Background: Hydrocephalus is the commonest pediatric neurological disorder and usually treated by cerebrospinal fluid (CSF) diversion. This diversion accomplished by third ventriculostomy or ventriculo-peritoneal shunt. However, the optimal management is still controversial.

Aim of the work: To compare the endoscopic third ventriculostomy (ETV) to ventriculo-peritoneal (VP) shunt in management of Infantile hydrocephalus**.**

Patients and Methods: We conducted a retrospective analysis for 40 infants with hydrocephalus. The treatment used was CSF diversion by ETV or VP shunt.

Results: oth treatment groups were comparable regarding age, gender, cause of hydrocephalus, incidence of postoperative re-obstruction, OFC change, hematoma, revision surgery, mortality or success rate. However, the operative time was significantly reduced among ETV when compared to VP shunt group (48.80±9.13 vs 66.75±7.65 minutes, respectively). The rate of postoperative infection was significantly decreased in ETV when compared to VP shunt groups (15.0% vs 45.0% respectively). Finally, the overall mortality during postoperative one year follow up duration was 42.5% with no significant difference between ETV and VP shunt groups (35.0% vs 50.0% respectively). In addition, the overall failure rate was 50.0%, which was lower among ETV when compared to V shunt groups (35.0% vs 65.0% respectively) with no significant difference.

Conclusion: Endoscopic third ventriculostomy is effective and safe intervention for treatment of infantile hydrocephalus (for infants between 6 and 3 years of age). It is superior to VP shunt as it is associated with lower postoperative infection and shorter operation time, when compared to shunt.

Keywords: Third ventricle; Ventriculostomy; Ventriculo-peritoneal; Shunt; Hydrocephalus.

Please cite this article as: **Alhady MEA, Youssef M. Our Experience with The Treatment of Hydrocephalus in Infants: Endoscopic Third Ventriculostomy versus Ventriculo-Peritoneal Shunt: A retrospective Comparative Study. IJMA 2020; 2[3]: 567-571.**

* Main subject and any subcategories have been classified according to the research topic.

INTRODUCTION

Hydrocephalus is one of the most common pediatric neurological diseases, and associated with significant morbidity [1]. It is estimated that, congenital hydrocephalus incidence range between 0.5 to 1 case per 1000 births and acquired hydrocephalus is 3 to 6 cases per 1000 births[2]. The majority of cerebrospinal Fluid (CSF) is produced within the lateral, 3rd and 4th ventricles, from the choroid plexus. It then travels through subarachnoid spaces to be absorbed through arachnoid granulations into the venous sinuses and systemic circulation[3]. Hydrocephalus is a complex condition had multiple factors responsible for its pathogenesis. In addition, it was classified from different points of view. In one classification, hydrocephalus is categorized as obstructive or communicating. The obstructive type (from its name) defined when there is an obstruction in the CSF flow. Obstruction could be due to aqueductal stenosis or post-meningitis. In communicating type on the other side, there is reduction in CSF reabsorption. Other classifications include Acquired versus developmental (congenital) and syndromic versus non-syndromic [4].

The main treatment modality for hydrocephalus is the diversion of CSF. Different diversion procedures were in action, including shunt procedures through ventriculo-peritoneal (VP), ventriculo-atrial (VA), lumbo-peritoneal, ventriculo-pleural shunt and endoscopic third ventriculostomy (ETV)[5]. VP shunts had been widely practiced. However, the main drawbacks of this procedure include shunt infection and malfunction (e.g., obstruction, over- or under-drainage, and shunt failure)[6].

ETV gained wide acceptance over VP shunt, as it is minimally invasive procedure and represents a reasonable solution for hydrocephalus. However, obstruction, infection, CSF leakage, intra-ventricular hemorrhage, and damage to the tuber cinereum with diabetes insipidus, are the main drawbacks of the procedure[7,8]. Nowadays, endoscopic third ventriculostomy (ETV) is the first choice for obstructive hydrocephalus because of the quality of the endoscopic instrument and imageology, and it had yielded excellent results. This approach has been used for infantile obstructive hydrocephalus[9]. However, the relative effectiveness between ETV and VPS in infants with hydrocephalus remains controversial.

AIM OF THE WORK

The current study had been conducted to represent our experience with endoscopic third ventriculostomy and ventriculo-peritoneal shunt regarding success rate and complications, in management of infantile hydrocephalus.

PATIENTS AND METHODS

This study was a retrospective analytic study, which included 40 infants, who were presented with hydrocephalus (≤ 2 years of age) whom CSF diversion had been performed using either ETV or VP shunt. All surgical interventions were held at Neurosurgery department, Al-Azhar University Hospital [New Damietta] between February 2016 and June 2019.

Inclusion criteria: infants with the following criteria were included: 1) Age between 6 months to 2 years (the most common age of presentation among infants), 2) who had congenital or post-meningitis hydrocephalus (the most common type at this age). On the other side, infants with: 1) age < 6 months or > 2 years, 2) those with secondary hydrocephalus due to any cause (e.g., intracranial hemorrhage, subarachnoid hemorrhage (SAH), or any space occupying lesion (SOL)), were **excluded** from the study.

Ethical considerations: as a routine in our institution, guardians provide consent before surgery, and another administrative consent was obtained to review data of studied infants. Confidentiality was guaranteed. In addition, the study protocol was approved by the local institutional review board (IRB) of Damietta Faculty of Medicine, Al-Azhar University (IRB number: 16-01-001).

Preoperative Assessments

As a routine, all infants exposed to basic clinical assessment with stress on manifestations of hydrocephalus (head circumference is at or above the 98th percentile for age, dilated scalp veins, tense fontanels, and sun set appearance). In addition, computed tomography scanning was carried out to evaluate the ventricular dilatation. Hydrocephalus was recognized according to the following criteria: temporal horns above ≥2mm in width, FH/ID ratio above 0.5 (where FH is the largest width of the frontal horns, and ID is the internal diameter from inner-table to inner-table at this level), ballooning of frontal horns of lateral ventricles. Additional MRI was done to detect any malformations. Surgical procedures were completed as described by Greenfield et al.[10] and Gonzalez et al.[11]. Endoscopic third ventriculostomy failure was nominated if there was a need for repeated surgery for hydrocephalus, or when there was a death related to hydrocephalus treatment[12]. Post-operatively, patients had been evaluated for their conscious level, cranial wound, abdominal wound, head circumference, and pumping function of the reservoir in VP shunt cases. Postoperative CT scan was done to evaluate proximal limb of the VP shunt, ventricular drainage, size and presence of any complications e.g. intra ventricular hemorrhage. MRI used to detect even slow flow through the stoma of ETV.T2 Fast-Field Echo sequence was done for cysts detection and assessment of CSF pathways patency.

Statistical analysis: collected data fed to personal computer after proper coding and analyzed with IBM SPSS Statistics, version 20 package. Descriptive statistics calculated to summarize collected data. Categorical variables presented as percentages and continuous data as means with standard deviations. For comparison, Student's [*t*] and Chi square tests were used. Statistical results were considered significant if the p value was < 0.05.

RESULTS

In the current work, 40 infants were included; 20 in each group; their age ranged between 7 to 23 months, and there was no significant difference between ETV and VP shunt groups (11.10±3.11 vs 11.90±3.19 respectively). In addition, males represented 60.0% of all studied infants, with no significant difference between EVT and VP shunt groups (e.g., males represented 55% and 65% of ETV and VP shunt groups respectively). The cause of hydrocephalus was congenital among 65.0% and post-meningitis among 35.0%; and there was no significant difference between ETV and VP shunt groups (The congenital type represented 70% and 60% in ETV and VP shunt groups respectively) (Table 1).

The operative time ranged between 40 and 80 minutes, and there was statistically significant decrease of operative time among ETV when compared to VP shunt group (48.80±9.13 vs 66.75±7.65 minutes, respectively). The rate of postoperative infection in overall study was 30.0%, with significant decrease in ETV when compared to VP shunt groups (15.0% vs 45.0% respectively). In addition, re-obstruction, change in OFC, hematoma and need for revision surgery were lower among ETV group when compared to VP shunt group (25.0%, 20.0%, 0.0%, 30.0% vs 40.0%, 25.0%, 5.0% and 50.0% successively). However, the difference did not reach statistical significance. Finally, the overall mortality during postoperative one year follow up duration was 42.5% with no significant difference between ETV and VP shunt groups (35.0% vs 50.0% respectively). In addition, the overall failure rate was 50.0%, which was lower among ETV when compared to V shunt groups (35.0% vs 65.0% respectively) with no significant difference (Table 2).

Table [1]: Patient characteristics and cause of hydrocephalus among studied groups

Variable		ETV group	VP shunt group	Total	Test	P value
Age (months)		11.10±3.11; 8-22	11.90±3.19;7-23	11.50±3.15; 7-23	0.79	0.43
Sex	**Male**	11(55.0%)	13(65.0%)	24(60.0%)	0.41	0.52
	Female	9(45.0%)	7(35.0%)	16(40.0%)		
Cause	**Congenital**	14(70.0%)	12(60.0%)	26(65.0%)	0.44	0.50
	Post-meningitis	6(30.0%)	8(40.0%)	14(35.0%)		

Table (2): Outcome among studied groups

Variable	ETV group	VP shunt group	Total	Test	P value
Operative time (minutes)	48.80±9.13;40-70	66.75±7.65;50-80	57.77±12.32;40-80	6.73	<0.001*
Postoperative infection	3(15.0%)	9(45.0%)	12(30.0%)	4.29	0.038*
Re-obstruction	5(25.0%)	8(40.0%)	13(32.5%)	1.02	0.31
OFC change (increased)	4(20.0%)	5(25.0%)	9(22.5%)	0.14	0.70
Hematoma	0(0.0%)	(5.0%)	1(2.5%)	1.02	0.31
Need for revision surgery	6(30.0%)	10(50.0%)	16(40.0%)	1.66	0.19
Overall mortality	7(35.0%)	10(50.0%)	17(42.5%)	0.92	0.33
Overall failure rate	7(35.0%)	13(65.0%)	20(50.0%)	3.60	0.06

OFC: occipital frontal circumference

DISUCSSION

In the present work, we retrospectively analyzed the results of hydrocephalus treatment either by endoscopic third ventriculostomy (ETV) or ventriculo-peritoneal (VP) shunt. Results revealed that, ETV is significantly superior over VP shunt in two ways; the first is the shorter operative time and the second is the lower rate of postoperative infections. In addition, ETV was better than VP-shunt in re-obstruction rate, need for revision surgery and overall success rate, but the difference did not reach statistical significance. **Lu L et al. [9]** in their meta-analysis of randomized controlled trials, reported that, ETV effectively decrease the overall rate of postoperative complications and mortality when compared to VPS. They added, despite the fact that, VPS is frequently used in hydrocephalus treatment, it is associated with higher rate of infection (26 cases) compared to only (one case in ETV group) in all included studies, which was significantly different. In addition, mortality was significantly higher among VP shunt group due to increase rate of infection and sepsis. These results are supported by the current study and this could be explained by need for wide surgical area and the use of implantable devices in VP shunt operation, when compared to ETV surgery[12]. In addition, the shunt blockade could be attributed to the presence of CSF cells with high protein content which facilitates the easily deposition of sediment. In addition, cell injury of intraventricular choroid plexus could cause accumulation of cell debris on the shunt tube with subsequent obstruction. Furthermore, the greater omentum of pseudocyst around the peritoneal end could be responsible for that obstruction[13].

The rate of postoperative hematoma in the current work is 2.5% (one case in VP shunt group). This rate is higher than the 1.08% rate reported by **Zhou and Liu[14]**. This hematoma could be due to multiple catheterizations, injury to venous system, excessive drainage (subdural hematoma) [15]. **Lu L et al.(9)** reported that, their meta-analysis confirmed that ETV is associated with significant risk reduction of postoperative hematoma when compared to VP shunt.

Although treatment patients with different inclusion criteria (infants younger than 6 months), **Lipina et al.[16]** reported results of 14 infants with hydrocephalus. The etiology was congenital aqueduct stenosis (35.7%), post-hemorrhagic (57.14), and combined post-hemorrhagic and post-infection (7.1%), they advocated the use of ETV as the standard treatment technique for hydrocephalus among infants younger than 6 months of age. A meta-analysis conducted in 2018 by Saekhu et al.[17] concluded a meta-analysis for randomized controlled trials [RCT] and reported that, none of the two surgeries was superior to each other after one year of follow up for surgical failure rate. This could be explained by the different factors (differences ages, duration of follow up, study design, available surgical instruments and study bias). However, another meta-analysis demonstrated that, ETV had lower overall complication rate, infection, and revision surgery, shorter operative time and hospital stay duration but were comparable as regard to rate of symptom improvement, hematoma, and mortality when compared to VP shunt[18]. Finally, **Abdel-Aziz et al.[19]** concluded that, ETV is superior than VPS as it is associated with lower rate of postoperative infection, shorter duration of operation. But they could not discover statistical difference regard PO obstruction, need for revision surgery or overall survival. These results agree with the current study.

ETV itself has its own advantages over VPS: no foreign objects (shunt tube or valve), with avoidance of catheter related complications (e.g., obstruction, infection, over-drainage, and need for revision with advanced age). The major advantage of ETV is that CSF drainage is near to its physiological condition once the ETV was well-established. Unfortunately, it could be guaranteed forever[20-21]. **Warf[22]** conducted one of the largest studies and reported on ETV success in young infants (153 infants < 1 year of age). The reported success rate of ETV was 53%.

Conclusion: Endoscopic third ventriculostomy is effective and safe intervention for treatment of infantile hydrocephalus (for infants between 6 and 2 years of age). It is superior to VP shunt as it is associated with lower postoperative infection and shorter operation time. However, the retrospective nature and small number of included infants were limiting steps against globalization of the current results. However, the strict inclusion criteria represent a main strength point of the current work.

Financial and Non-Financial Relationships and Activities of Interest

None declared by the authors

REFERENCES

1. **Zaben M, Manivannan S, Sharouf F, Hammad A, Patel C, Bhatti I, et al.** The efficacy of endoscopic third ventriculostomy in children 1 year of age or younger: A systematic review. Eur J Paediatr Neurol. **2020**; 26: 7-14. [DOI: 10.1016/j.ejpn.2020.02.011].
2. **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: Clinical article. J Neurosurg Pediatr. **2014**;13(3):295–300. [DOI: 10.3171/2013.11. PEDS13138].
3. **Sakka L, Coll G, Chazal J.** Anatomy and physiology of cerebrospinal fluid. Eur Ann Otorhinolaryngol Head Neck Dis. **2011**;128(6):309–16. [DOI: 10.1016/j.anorl. 2011.03.002].
4. **Tully HM, Dobyns WB.** Infantile hydrocephalus: a review of epidemiology, classification and causes. Eur J Med Genet. **2014**; 57(8): 359–368. [DOI: 10.1016/j.ejmg. 2014.06.002].
5. **Wright Z, Larrew TW, Eskandari R.** Pediatric Hydrocephalus: Current State of Diagnosis and Treatment. Pediatr Rev. **2016** Nov;37(11):478-490. [DOI: 10.1542/ pir.2015-0134].
6. **Texakalidis P, Tora MS, Wetzel JS, Chern JJ.** Endoscopic third ventriculostomy versus shunt for pediatric hydrocephalus: a systematic literature review and meta-analysis. Childs Nerv Syst. **2019** Aug;35(8):1283-1293. [DOI: 10.1007/s00381-019-04203-2].
7. **Feng Z, Li Q, Gu J, Shen W.** Update on Endoscopic Third Ventriculostomy in Children. Pediatr Neurosurg. **2018**; 53(6): 367-370. [DOI: 10.1159/000491638].
8. **Demerdash A, Rocque BG, Johnston J, Rozzelle CJ, Yalcin B, Oskouian R, Delashaw J, Tubbs RS.** Endoscopic third ventriculostomy: A historical review. Br J Neurosurg. **2017** Feb;31(1):28-32. [DOI: 10.1080/ 02688697.2016.1245848].
9. **Lu L, Chen H, Weng S, Xu Y.** Endoscopic Third Ventriculostomy versus Ventriculoperitoneal Shunt in Patients with Obstructive Hydrocephalus: Meta-Analysis of Randomized Controlled Trials. World Neurosurg. **2019** Sep; 129:334-340. [DOI: 10.1016/ j. wneu.2019.04.255].
10. **Greenfield JP, Hoffman C, Kuo E, Christos PJ, Souweidane MM:** Intraoperative assessment of endoscopic third ventriculostomy success. J Neurosurg Pediatr. **2008;** 2:298–303. [DOI: 10.3171/PED.2008. 2.11.298].
11. **Gonzalez DO, Mahida JB, Asti L, Ambeba EJ, Kenney B, Governale L, Deans KJ, Minneci PC.** Predictors of ventriculoperitoneal shunt failure in children undergoing initial placement or revision. Pediatr Neurosurg. **2017**; 52(1): 6-12. [DOI: 10.1159/ 000447410].
12. **Kulkarni AV, Riva-Cambrin J, Holubkov R, Browd SR, Cochrane DD, Drake JM, et al.** Endoscopic third ventriculostomy in children: prospective, multicenter results from the Hydrocephalus Clinical Research Network. J Neurosurg Pediatr. **2016**; 18 (4): 423-429. [DOI: 10.3171/2016.4. PEDS163]
12. **Simon TD, Butler J, Whitlock KB, Browd SR, Holubkov R, Kestle JR, et al.** Risk factors for first cerebrospinal fluid shunt infection: findings from a multi-center prospective cohort study. J Pediatr. **2014**; 164:1462-1468. [DOI: 10.1016/j.jpeds.2014.02.013].
13. **Reddy GK, Bollam P, Caldito G.** Long-term outcomes of ventriculoperitoneal shunt surgery in patients with hydrocephalus. World Neurosurg. **2014** Feb;81(2):404-10. [DOI: 10.1016/j.wneu. 2013.01.096].
14. **Zhou F, Liu Q, Ying G, Zhu X.** Delayed intracerebral hemorrhage secondary to ventriculoperitoneal shunt: two case reports and a literature review. Int J Med Sci. **2012**; 9:65-67. [DOI:10.7150/ijms.9.65].
15. **Calayag M, Paul AR, Adamo MA.** Intraventricular hemorrhage after ventriculoperitoneal shunt revision: a retrospective review. J Neurosurg Pediatr. **2015**; 16:42-45. [DOI: 10.3171/2014.11. PEDS14246].
16. **Lipina R, Reguli S, Dolezilová V, Kuncíková M, Podesvová H.** Endoscopic third ventriculostomy for obstructive hydrocephalus in children younger than 6 months of age: is it a first-choice method? Childs Nerv Syst. **2008** Sep;24(9):1021-7. [DOI: 10.1007/s00381-008-0616-6].
17. **Saekhu M, Pujiastono ES, Santoso F.** Endoscopic Third Ventriculostomy (ETV) versus Ventriculo-peritoneal Shunt (VPS) for pediatric hydrocephalus: a meta-analysis. Indonesian Journal of Neurosurgery (IJN) **2018**; 1(1): 10-18. [DOI:10.15562/ijn. v1i1.14].
18. **Jiang L, Gao G, Zhou Y.** Endoscopic third ventriculostomy and ventriculoperitoneal shunt for patients with noncommunicating hydrocephalus: A PRISMA-compliant meta-analysis. Medicine (Baltimore). **2018** Oct; 97(42): e12139. [DOI: 10.1097/MD. 00000000000 12139].
19. **Abdel-Aziz KI, Nouby R, Thabet MA, Elshirbiny MF.** Endoscopic Third Ventriculostomy versus Ventriculo-Peritoneal Shunt for Infant Hydrocephalus. Open J Modern Neurosurg **2020**; 10:193-202. [DOI: 10.4236/ojmn.2020.102020].
20. **Waqar M, Ellenbogen JR, Mallucci C.** Endoscopic third ventriculostomy for shunt malfunction in children: A review. J Clin Neurosci. **2018** May; 51:6-11. [DOI: 10.1016/j.jocn. 2018.02. 012].
21. **Uche EO, Okorie C, Iloabachie I, Amuta DS, Uche NJ.** Endoscopic third ventriculostomy (ETV) and ventriculo peritoneal shunt (VPS) in non-communicating hydrocephalus (NCH): comparison of outcome profiles in Nigerian children. Childs Nerv Syst. **2018** Sep; 34(9): 1683-1689. [DOI: 10.1007/ s00381-018-3848-0].
22. **Warf BC.** Hydrocephalus in Uganda: The Predominance of Infectious Origin and Primary Management with Endoscopic Third Ventriculostomy. J Neurosurg **2005;** 102: 1-15. [DOI:10.3171/ped. 2005.102.1.0001].