MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2023.376.381

An Analysis on the Endoscopic Third Ventriculostomy in Shunt Malfunction Surgeries

Rajesh Jain, Akshay Baid and Ashu Jain

Department of General Surgery, Raipur Institute of Medical Sciences, Raipur, CG, India

OPEN ACCESS

Key Words
ETV, shunt malfunction, reversal shunt, hydrocephalus

Corresponding Author
Akshay Baid,
Department of General Surgery, Raipur Institute of Medical Sciences, RIMS Medical College and Hospital, Off NH-6, Bhansoj Road, Godhi, Raipur (C.G) 492101, India

Received: 16 June 2023
Accepted: 28 June 2023
Published: 3 July 2023

Citation: Rajesh Jain, Akshay Baid and Ashu Jain, 2023. An Analysis on the Endoscopic Third Ventriculostomy in Shunt Malfunction Surgeries. Res. J. Med. Sci., 17: 376-381, doi: 10.59218/makrjms.2023.376.381

ABSTRACT
Endoscopic third ventriculostomy (ETV) is indicated for both communicating and noncommunicating types of hydrocephalus and for various etiologies of hydrocephalus, including infection, congenital malformations, such as aqueductal stenosis, congenital cysts, mega cisterna magna and Arnold-Chiari malformation, hemorrhage and tumor. Hence in this study, in which it is analysed and assessed the usefulness of ETV in cases of ventriculoperitoneal shunt malfunction. This Analytical Prospective study involved Prior Consent from the patients and was found to be within ethical standards. About 26 patients were enrolled who underwent ETV for shunt malfunction presenting to various tertiary health tertiary medical care institutes/hospitals. The choice to proceed with ETV was based on discussion on the risks and benefits of the procedure with the patient and attendants. All patients had a minimum of 12 months of follow-up. In our study the use of ETV in patients with shunt malfunction resulted in shunt independence in 61.53% patients. ETV was successful in 17.65% of patients aged $\leq$2 years and in 82.35% of patients aged >2 years. Nearly 81.81% patients who had normal third ventricle anatomy observed during endoscopy had successful outcome whereas, 53.33% patients who were having indistinct anatomy observed during the procedure had successful outcome. There were 4 complications 15.38% associated with ETV and shunt removal in our series. ETV is a good procedure for patients who present with shunt malfunction. It is a technically demanding procedure and needs expertise. It has got its own complications but it relieves a patient from the everlasting complications of shunt surgery. Limitations of study were Low sample size/Lesser number of patients in the study.

INTRODUCTION

Shunt placement was a standard treatment for patients with hydrocephalus. Although, ventriculostomy for shunt malfunction has been described since the 1960s, surgeons were largely reluctant to use the technique until the advent of refined neuroendoscopic techniques in the late 1990s, when its use became more widespread[1,2]. It is indicated for both communicating and noncommunicating types of hydrocephalus and for various etiologies of hydrocephalus, including infection; congenital malformations, such as aqueductal stenosis, congenital cysts, mega cisterna magna and Arnold-Chiari malformation, hemorrhage, and tumor. The risk of shunt malfunction is quite high: 25-40% in the first year after shunt placement, 4-5% per year thereafter and 81% of shunted patients require revision after 12 years. Therefore, it is considered that shunt failure is almost inevitable during a patient's life. Endoscopic third ventriculostomy (ETV) is commonly used to manage patients with obstructive hydrocephalus, either as a first-line procedure (primary ETV), or in the setting of shunt malfunction (secondary ETV)[1-3].

There are several important factors that surgeons performing a secondary ETV should consider. These can be broadly divided based on clinical course into preoperative, operative and postoperative factors. Preoperatively, the choice of CSF diversion procedure is most important. Scoring systems have been developed to aid clinician decision making, particularly with regards to the likelihood of ETV success[4]. Aetiology of hydrocephalus is a particularly important prognostic indicator. Operative factors include: surgeon technical experience-distorted ventricular anatomy can arise from chronic shunting, management of existing shunt hardware-whether to leave it in, ligate it or remove it entirely and whether to anticipate ETV failure, most likely in the early postoperative period, by employing an external ventricular drain or ventricular access device. Postoperative factors include the decision to use ICP monitoring and follow-up after hospital discharge[2,3,5].

Endoscopic third ventriculostomy (ETV) for hydrocephalus is an important advancement for patients with hydro- cephalus. The results are different when it is performed after shunt failure (secondary ETV) than when it is performed as an initial treatment modality for hydroce-phalus (primary ETV). Complications that are reported with ETV include herniation syndromes and arrhythmia at the time of ETV, injury to the hypothalamic-pituitary axis and structures adjacent to floor of the third ventricle, including cranial nerves and major vessels, resulting in subarachnoid hemorrhage or ischemic stroke, with creation of ventricu-lostomy, as well as remote intracranial hemorrhage and infection and severe cognitive and psychiatric sequelae[2-5]. Hence this study, in which it is analysed and assessed the usefulness of ETV in cases of ventriculoperitoneal shunt malfunction.

MATERIALS AND METHODS

This analytical prospective study involved Prior Consent from the patients and was found to be within ethical standards. It was conducted among patients admitted to or attending to various tertiary health tertiary medical care institutes/hospitals in Raipur CG.

About 26 patients were enrolled who underwent ETV for shunt malfunction presenting to various tertiary health tertiary medical care institutes/hospitals in and around Raipur, CG where ever the surgical team visits regularly including our institution's neurosurgical service between January 2015 and December 2020. All patients had a minimum of 12 months of follow-up. In this study shunt malfunction was diagnosed in all cases with increased ventricular size in comparison with baseline investigations of computed tomographic (CT) or magnetic resonance imaging (MRI) findings associated with at least one symptom or sign of increased intracranial pressure (headache, vomiting, deterioration of conscious level) or shunt obstruction (shunt chamber not compressible or refilling). Patients who had earlier undergone shunt surgery and now presented with shunt malfunction were enrolled in the study. Patients who underwent ETV as a primary procedure were excluded from the study. Outcome was considered successful if the patient became shunt independent[5].

The choice to proceed with ETV was based on discussion on the risks and benefits of the procedure with the patient and attendants. An incision was made over Kocher's point and burr hole was performed. A ventricular catheter was then used to cannulate the lateral ventricle. This track was then followed under direct visualization with a 0-degree scope. The floor of the third ventricle was then perforated and dilated with a 3F/4F Fogarty catheter. Bipolar cautery and irrigation were used as necessary for hemostasis. The interpeduncular and pontine cisterns were inspected for the Liliequist membrane or any other arachnoid adhesions. Liliequist membrane, if present, was punctured. The scope was then removed, the burr hole was plugged with gel foam and a layered closure was subsequently performed. The correlation between the success of ETV and patient's age at surgery, etiology of hydrocephalus, number of shunt revisions, third ventricle anatomy and third ventricle floor were tested with the chi-square test, with $p<0.05$ indicating statistical significance.

Data was filled in Microsoft Excel and analysed using the Statistical Package for Social Sciences (SPSS) for Windows version 23 and a computer software Epi

Info version 6.2 (Atlanta, Georgia, USA). For unpaired observations (ambulatory and non ambulatory) quantitative and qualitative data were confirmed to be parametric and analyzed with student t test and Fisher exact test respectively. For paired observations (before and after treatment) paired t-test was used for quantitative data and Mc Nemar's test was used for qualitative data.

RESULTS

Over the study period, 26 patients underwent ETV for the treatment of shunt malfunction. Of these patients, 23 were males and 7 were females. The age range of patients in this study was 4 months to 59 years. The causes of hydro-cephalus were aqueductal stenosis in 11 patients, tumor in 5 patients, neurocysticercosis (NCC) in 2 patients, tuberculous meningitis (TBM) in 1 patient, posttraumatic in 6 patients and postmeningitic in 1 patient. Majority had noncommunicating hydrocephalus. Total 17 (65.38%) patients underwent successful ETV whereas ETV failure was seen in 9 (34.62%) patients. VP shunt insertion was done in all these patients.

Effect of age: ETV was successful in 17.65% of patients aged <u><</u>2 years and in 82.35% of patients aged >2 years (Table 1).

Effect of shunt revisions: Patients were divided into two groups: (1) Patients who underwent one shunt surgery prior to ETV and (2) Patients who underwent two or more shunt surgeries prior to ETV. In the first group, 57.14% patients had successful outcome, whereas in the second group 75% patients had successful outcome after ETV. Table 1 shows distribution of patients according to age and number of shunt revisions prior to ETV.

Effect of etiology of hydrocephalus: Majority patients were found to have non-communicating hydrocephalus whereas 8 patients had communicating hydrocephalus. In communicating hydrocephalus group, 37.5% patients had successful ETV. In noncommunicating group, the success rate was higher i.e., 83.33%.

In communicating hydrocephalus group, Maximum patients who presented with TBM with hydrocephalus had successful outcome after ETV. Patients with pyogenic meningitis as a cause of hydrocephalus had less successful outcome. ETV failed in majority patient who developed hydrocephalus following trauma (head injury).

In non-communicating hydrocephalus group, the causes for hydrocephalus in patients enrolled in our study were aqueductal stenosis, tumor and fourth ventricle NCC.

Majority patients with aqueduct stenosis who presented with shunt malfunction had a successful out-come after ETV. Nearly 100% patients in whom tumor was the cause of hydrocephalus had successful outcome. Patients presented with fourth ventricle NCC with shunt malfunction had a successful outcome.

Endoscopic findings

Effect of third ventricle anatomy: Endoscopic observations made during the procedure showed normal anatomy of the third ventricle in 11 patients and indistinct anatomy in 15 patients. Nearly 81.81% patients who had normal third ventricle anatomy observed during endoscopy had successful outcome whereas 53.33% patients who were having indistinct anatomy observed during the procedure had successful outcome.

Effect of third ventricle floor: Thickened third ventricle floor was found in 18 patients while performing ETV. Nearly 55.55% patients with thickened third ventricle floor had successful outcome. About 8 patients had normal third ventricle floor. Nearly 75% patients in this group had a successful outcome after the procedure. Table 2 shows distribution of patients according to endoscopic findings.

Table 1: Distribution of patients according to age and number of shunt revisions prior to ETV

	ETV success	ETV failure
No. of patients (n = 26)	17	9
Age (years)		
<2	3	4
>2	14	5
Shunt revisions prior to ETV		
<1	8	6
> 1	9	3

Table 2: Distribution of patients according to endoscopic findings

	ETV success	ETV failure
3rd ventricle anatomy		
Normal	9	2
Indistinct	8	7
3rd ventricle floor		
Normal	6	2
Thickened	10	8

DISCUSSIONS

ETV is a safe and effective procedure for the treatment of appropriately selected patients. Our overall success rate of patients is comparable with other studies. Buxton *et al*.[5] reported overall success rates of 52%. Cinalli *et al*.[5] reported ETV success in 76% patients whereas Marton *et al*.[6] reported 64% overall ETV success.

Majority patients with aqueduct stenosis/ obstructive hydrocephalus e.g., (Fig. 1) who presented with shunt malfunction had a successful out- come after ETV. Nearly 100% patients in whom tumor was the cause of hydrocephalus had successful outcome (Fig. 2). Patients presented with fourth ventricle NCC

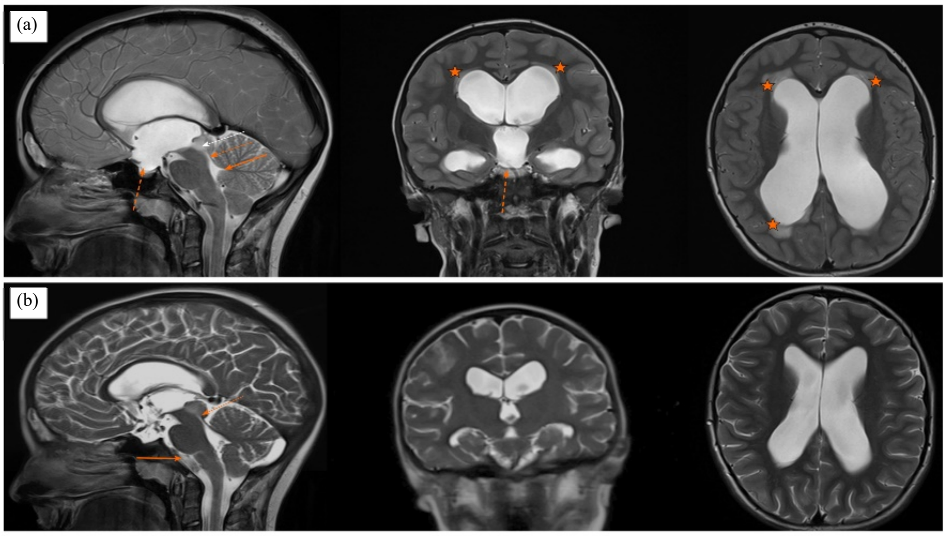

Fig. 1(a-b): The T2-phases of the magnetic resonance imaging (sagittal, coronal and axial views) revealing a tumour in the right part of the tectum (white arrow), obstructing the aqueduct of Sylvius and causing extensive hydrocephalus (a) The enlarged third ventricle is bulging into the sella turcica (dotted arrow). Periventricular lucences can also be seen (star). The thick arrow indicates the stenosis, the thin arrow indicates a normal fourth ventricle width and (b) After one year, the control MRI (T2-phase) showed the regression of ventriculomegaly as a result of the endoscopic third ventriculostomy (ETV). The stenosis in the aqueduct is still present to the same degree (thin arrow). The cerebrospinal fluid flow artefact in the third ventricle can be seen (thick arrow), confirming the third ventricle floor opening after the successful ETV. The tumour has not been progressing. The supratentorial ventricles are narrower

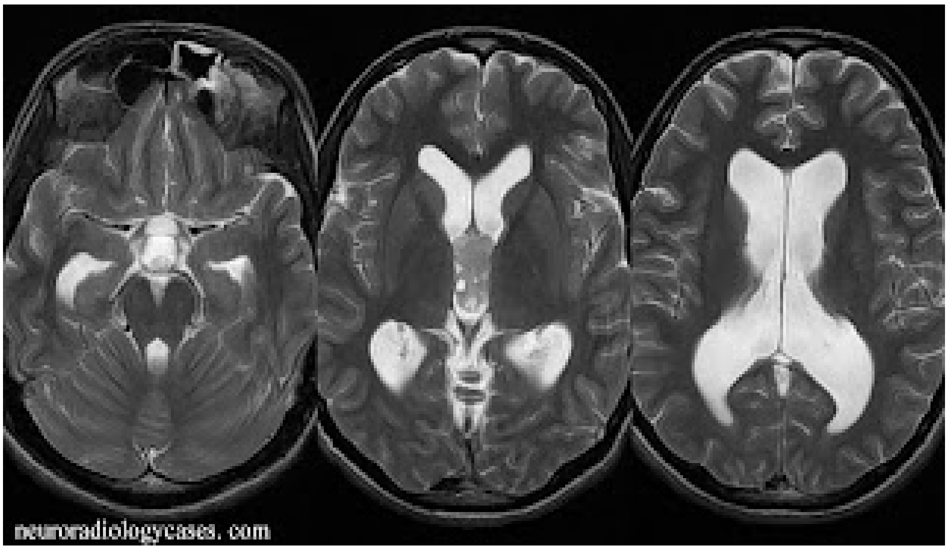

Fig. 2: An intra ventricular mass in third ventricle causing non communicating hydrocephalus

with shunt malfunction had a successful outcome. This result is comparable with the previous studies. Buxton *et al.*[4] reported success rate of 73% in noncommunicating hydrocephalus and 46% in communicating hydrocephalus. In our study patients with aque ductal stenosis who presented with shunt malfunction had high success rate .This is at par with that reported by the previous studies. In a study by Boschert *et al.*[7] 82% of their patients remained shunt free after procedure for aqueductal stenosis. In another study of O'Brien *et al.* [1] reported a success rate of 68% with the patients having aqueductal stenosis. In our study, a history of pyogenic meningitis was associated with low success rate. Our results

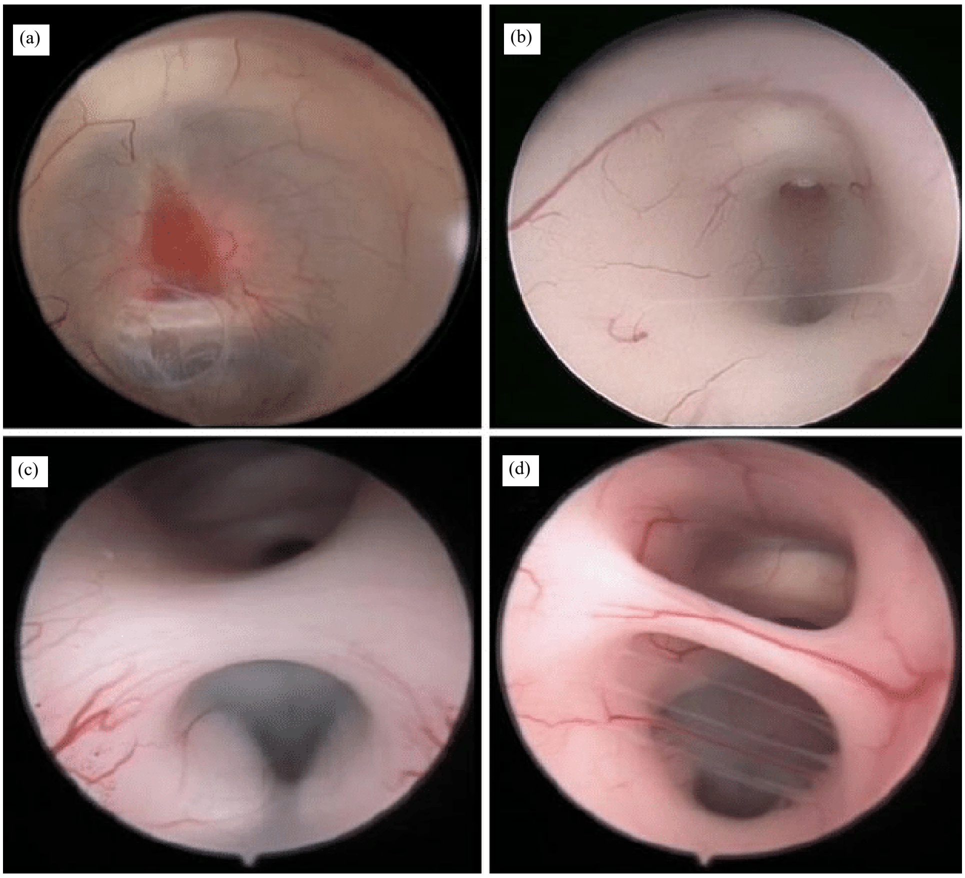

Fig. 3(a-d): Endoscopic pictures showing different appearance of the floor of the third ventricle, resulting in increasing difficulty to perform the ETV (a) Horizontal, translucent and thin with the well recognisable infundibulum, (b) Parenchymatous with a thin hypothalamic adhesion, (c) Parenchymatous with a thick hypothalamic adhesion and (d) Parenchymatous with a thick hypothalamic adhesion and several vessels

matched those reported by Fukuhara *et al*.[8] who also reported low success rate in these cases. One of the most commonly cited preoperative factors that predict outcome is the etiology of the hydrocephalus. However, Lee *et al*.[3] categorized hydrocephalus according to etiology, including neoplasm, infection, trauma, malformation and other causes and found no statistical significance between hydrocephalus etiology and ETV outcome. In our study we also did not find significant correlation between etiology and ETV outcome. This can be attributed to fewer number of patients enrolled in the study.

Patients who had TBM and presented with shunt malfunction had a satisfactory success rate in our study. This rate is at par with the rate ranging from 41-81% reported by various studies[9,10]. Success rates reported for ETV in patients aged $\leq$2 years vary from 0-83% with a mean of 47.8%, which is significantly lower than the success rate in older children[11-14]. Marton *et al*.[6]. reported that age at the time of secondary ETV has no statistically significant effect. ETV was successful in 17.65% of patients aged $\leq$2 years and in 82.35% of patients aged >2 years. This is in accordance to the previous studies[10-14].

Defining success after endoscopic third ventriculostomy: Successful outcome was considered when the patient became shunt independent. In the existing literature, success of ETV has been most commonly defined as enduring shunt independence after the procedure[11,13-14].

Removal of shunt: Shunt was removed ventriculoperitoneal shunt in all patients who underwent ETV. Removal of shunt can be decided during ETV as we can look for whether shunt tip is free or is struck in the choroid plexus. Shunt removal in patients in whom shunt is present for long time is prone for difficult removal, so shunt can be ligated in such cases.

Complications of Endoscopic third Ventriculostomy There were 4 complications (15.38%) associated with ETV and shunt removal in our series. Other series have reported complication rates ranging from 6-14%[11,13,14]. Hemorrhage was seen in two patients intraoperatively during ETV, which was managed with irrigation and cautery. Two patient had hemorrhage in shunt tract, which occurred while removal of shunt. Our complication rate is comparable with that reported by the previous studies[9-14].

CONCLUSION

In our study the use of ETV in patients with shunt malfunction resulted in shunt independence in 61.53% patients. Study with more number of patients will further elucidate the relation of these factors with ETV outcome. ETV is a good procedure for patients who present with shunt malfunction. It is a technically demanding procedure and needs expertise. It has got its own complications but it relieves a patient from the everlasting complications of shunt surgery

LIMITATIONS OF STUDY

- Low sample size
- Lesser number of patients in the study

ACKNOWLEDGMENTS

We would like to thank all the Participating patients, Our Head of Department and Dean for his always available guidance.

REFERENCES

1. O'Brien, D.F., M. Javadpour, D.R. Collins, P. Spennato and C.L. Mallucci, 2005. Endoscopic third ventriculostomy: An outcome analysis of primary cases and procedures performed after ventriculoperitoneal shunt malfunction. J. Neurosurg., 103: 393-400.
2. Prusseit, J., M. Simon, C. von der Brelie, A. Heep, E. Molitor, S. Völz and A. Simon, 2009. Epidemiology, prevention and management of ventriculoperitoneal shunt infections in children. Pediatr. Neurosurg, 45: 325-336.
3. Lee, S.H., D.S. Kong, H.J. Seol and H.J. Shin, 2011. Endoscopic third ventriculostomy in patients with shunt malfunction. J. Korean Neurosurgical Soc., 49: 217-221.
4. Buxton, N., D. Macarthur, I. Robertson and J. Punt, 2003. Neuroendoscopic third ventriculostomy for failed shunts. Surg Neurol, 60: 201-203.
5. Cinalli, G., C. Salazar, C. Mallucci, J.Z. Yada, M. Zerah and C. Sainte-Rose, 1998. The role of endoscopic third ventriculostomy in the management of shunt malfunction. Neurosurgery, 43: 1323-1327.
6. Marton, E., A. Feletti, L. Basaldella and P. Longatti, 2010. Endoscopic third ventriculostomy in previously shunted children: A retrospective study. Child's Nervous Syst., 26: 937-943.
7. Boschert, J., D. Hellwig and J.K. Krauss, 2003. Endoscopic third ventriculostomy for shunt dysfunction in occlusive hydrocephalus: Long-term follow up and review. J. Neurosurg., 98: 1032-1039.
8. Fukuhara, T., S.J. Vorster and M.G. Luciano, 2000. Risk factors for failure of endoscopic third ventriculostomy for obstructive hydrocephalus. Neurosurgery, 46: 1100-1111.
9. Singh, D., V. Sachdev, A.K. Singh and S. Sinha, 2005. Endoscopic third ventriculostomy in post-tubercular meningitic hydrocephalus: A preliminary report. min Minimally Invasive Neurosurg., 48: 47-52.
10. Yadav, Y.R., V. Parihar, M. Agrawal and P.R. Bhatele, 2011. Endoscopic third ventriculostomy in tubercular meningitis with hydrocephalus. Neurol. India, 59: 855-860.
11. Amini, A., R.H. Schmidt, 2005. Endoscopic third ventriculostomy in a series of 36 adult patients. Neurosurg Focus, Vol. 19.
12. Baldauf, J., J. Oertel, M.R. Gaab and H.W.S. Schroeder, 2007. Endoscopic third ventriculostomy in children younger than 2 years of age. Child's Nervous Syst., 23: 623-626.
13. Beems, T. and J.A. Grotenhuis, 2004. Long-term complications and definition of failure of neuroendoscopic procedures. Child's Nervous Syst., 20: 868-877.
14. Hellwig, D., J.A. Grotenhuis, W. Tirakotai, T. Riegel, D.M. Schulte, B.L. Bauer and H. Bertalanffy, 2004. Endoscopic third ventriculostomy for obstructive hydrocephalus. Neurosurgical Rev., 28: 1-34.