Role of Endoscopic Third Ventriculostomy in Shunt Malfunction

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Abstract

Background Shunt placement was a standard treatment for patients with hydrocephalus. The risk of shunt malfunction is quite high. Endoscopic third ventriculostomy (ETV) for hydrocephalus is an important advancement for patients with hydrocephalus. The aim is to study the role of ETV in patients with ventriculoperitoneal shunt malfunction.

Methods A prospective study of 21 patients with shunt malfunction, who underwent secondary ETV instead of shunt revision, was conducted in Department of Neurosurgery, PGIMER, and Dr. RML Hospital, New Delhi. Patients data included age, cause of hydrocephalus, number of previous shunt surgeries, and outcome after ETV. Shunt was removed in all patients at the time of ETV. Success was defined as shunt independence till the last follow-up.

Results There were 17 males and 4 females. The age range was 2 months to 53 years. Eleven patients had communicating and 10 patients had noncommunicating hydrocephalus. Overall success rate of ETV was 61.90% with 80% (8/10) in noncommunicating and 45.45% (5/11) in communicating hydrocephalus. None of the possible contributing factors for successful ETV, including age ($p = 0.088$), the etiology of hydrocephalus ($p = 0.296$), and number of previous shunt surgeries ($p = 0.399$), were statistically significantly correlated with outcome in our series. Overall complication rate was 14.2%. No death was reported.

Conclusion ETV is an effective alternative for patients who present with shunt malfunction. Age, etiology, type of hydrocephalus, and number of shunt revisions did not have a significant impact on outcome of ETV.

Keywords
- endoscopic third ventriculostomy
- shunt malfunction
- hydrocephalus

Introduction

Shunt placement was a standard treatment for patients with hydrocephalus. 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 to 40% in the first year after shunt placement, 4 to 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.[1–3]

Endoscopic third ventriculostomy (ETV) for hydrocephalus is an important advancement for patients with hydrocephalus. The results are different when it is performed after shunt failure (secondary ETV) than when it is

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performed as an initial treatment modality for hydrocephalus (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 ventriculostomy, as well as remote intracranial hemorrhage and infection and severe cognitive and psychiatric sequelae. In this study we assessed the usefulness of ETV in cases of ventriculoperitoneal shunt malfunction.

Materials and Methods

Ours was a prospective study. We enrolled 21 patients who underwent ETV for shunt malfunction presenting to our institution's neurosurgical service between January 2011 and December 2012. All patients had a minimum of 9 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.[4]

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.

Results

Over the study period, 21 patients underwent ETV for the treatment of shunt malfunction. Of these patients, 17 were males and 4 were females. The age range of patients in this study was 2 months to 53 years. The causes of hydrocephalus were aqueductal stenosis in seven patients, tumor in two patients, neurocysticercosis (NCC) in one patient, tuberculous meningitis (TBM) in six patients, posttraumatic in one patient, and postmeningitic in four patients. Communicating hydrocephalus occurred in 11 patients and noncommunicating hydrocephalus 10 patients.

Success and Failure

Total 13 patients (61.90%) underwent successful ETV whereas ETV failure was seen in 8 (38.1%) patients .VP shunt insertion was done in all these patients.

Variables Affecting Endoscopic Third Ventriculostomy Failure

We evaluated different variables for significant effect on ETV failure. We evaluated success and failure with respect to age, number of shunt revisions, etiology of hydrocephalus, third ventricle anatomy, and third ventricle floor.

- *Effect of age*: ETV was successful in 33.34% of patients aged ≤ 2 years and in 73.33% of patients aged > 2 years. However, the difference between success rates in both the groups was not statistically significant ($p = 0.088$).
- *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, 50% patients had successful outcome, whereas in the second group 77.78% patients had successful outcome after ETV. The difference between the two groups was not statistically significant ($p = 0.399$). ►**Table 1** shows distribution of patients according to age and number of shunt revisions prior to ETV.
- *Effect of etiology of hydrocephalus*: Total 11 patients were found to have communicating hydrocephalus whereas 10 patients had noncommunicating hydrocephalus. In communicating hydrocephalus group, 45.45% patients had successful ETV. In noncommunicating group, the success rate was higher (80%). However, the difference between success rates in both the groups was not statistically significant ($p = 0.104$).

In communicating hydrocephalus group, 66.67% patients who presented with TBM with hydrocephalus had successful outcome after ETV. Nearly 25% of patients with pyogenic meningitis as a cause of hydrocephalus had successful

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

		ETV Success	ETV Failure
No. of patients ($n = 21$)		13	8
Age (y)	< 2	2	4
	> 2	11	4
Shunt revisions prior to ETV	1	6	6
	> 1	7	2

Abbreviation: ETV, endoscopic third ventriculostomy.

outcome. ETV failed in patient who developed hydrocephalus following trauma (head injury).

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

Nearly 71.42% patients with aqueduct stenosis who presented with shunt malfunction had a successful outcome after ETV. Nearly 100% patients in whom tumor was the cause of hydrocephalus had successful outcome. One patient presented with fourth ventricle NCC with shunt malfunction and had a successful outcome after ETV. ►**Table 2** shows distribution of patients according to etiology of hydrocephalus

Endoscopic Findings

- *Effect of third ventricle anatomy*: Endoscopic observations made during the procedure showed normal anatomy of the third ventricle in 9 patients and indistinct anatomy in 12 patients. Nearly 77.78% patients who had normal third ventricle anatomy observed during endoscopy had successful outcome whereas 50% patients who were having indistinct anatomy observed during the procedure had successful outcome. The difference between the two groups was not statistically significant ($p = 0.195$).
- *Effect of third ventricle floor*: Thickened third ventricle floor was found in 15 patients while performing ETV. Nearly 53.33% patients with thickened third ventricle floor had successful outcome. Six patients had normal third ventricle floor. Nearly 83.33% patients in this group had a successful outcome after the procedure. The difference between the two groups was not statistically significant ($p = 0.201$). ►**Table 3** shows distribution of patients according to endoscopic findings.

Discussion

ETV is a safe and effective procedure for the treatment of appropriately selected patients. Our overall success rate of 61.90% patients is comparable with other studies. Buxton et al[5] reported overall success rates of 52%. Cinalli et al[4] reported ETV success in 76% patients whereas Marton et al[6] reported 64% overall ETV success.

In our study the procedure was successful in 80% of noncommunicating hydrocephalus and 45.45% of communicating hydrocephalus. This result is comparable with the previous studies. Buxton et al[5] reported success rate of 73% in noncommunicating hydrocephalus and 46% in communicating hydrocephalus. In our study patients with aqueductal stenosis who presented with shunt malfunction had high success rate (80%).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, 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 (25%). Our results 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 success rate of 66.67% in our study. This rate is at par with the rate ranging from 41 to 81% reported by studies.[9,10] Success rates reported for ETV in patients aged ≤ 2 years vary from 0 to 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. In our series ETV was successful in 33.34% patients aged ≤ 2 years. In our study age was not found to be significant predictor of outcome of success of ETV in patients with shunt malfunction. This is in accordance to the aforementioned study.

Table 2 Distribution of patients according to etiology of hydrocephalus

	ETV success	ETV failure
Communicating hydrocephalus (11)	5	6
TBM	4	2
Postpyogenic meningitis	1	3
Posttraumatic	0	1
Noncommunicating hydrocephalus (10)	8	2
Congenital	5	2
Tumor	2	0
4th ventricle NCC	1	0

Abbreviations: ETV, endoscopic third ventriculostomy; NCC, neurocysticercosis; TBM, tuberculous meningitis.

Table 3 Distribution of patients according to endoscopic findings

	ETV success	ETV failure
3rd ventricle anatomy		
Normal	7	2
Indistinct	6	6
3rd ventricle floor		
Normal	5	1
Thickened	8	7

Abbreviation: ETV, endoscopic third ventriculostomy.

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.[11,13–15]

Removal of Shunt

We removed ventriculoperitoneal shunt in all patients who underwent ETV. In our study we encountered shunt tract hematoma in one patient after shunt removal. 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 three complications (14.2%) associated with ETV and shunt removal in our series. Other series have reported complication rates ranging from 6 to 14%.[11,13,14] Hemorrhage was seen in two patients intraoperatively during ETV, which was managed with irrigation and cautery. One patient had hemorrhage in shunt tract, which occurred while removal of shunt. Our complication rate is comparable with that reported by the previous studies.

Conclusion

In our study the use of ETV in patients with shunt malfunction resulted in shunt independence in 61.90% patients. Age, etiology, type of hydrocephalus, and number of shunt revisions did not have a significant impact on the outcome of ETV in our study. 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.

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