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Original Article

Endoscopic Third Ventriculostomy in Failed Ventriculoperitoneal Shunt in Pediatric Population

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Abstract

Introduction: Ventriculoperitoneal (VP) shunt malfunction is common in pediatric age group patients. There is a high complication rate and revision rate of VP shunt. Endoscopic third ventriculostomy (ETV) can alleviate these complications and can act as an effective alternative for the treatment of hydrocephalus in this age group of patients. **Materials and Methods:** The authors retrospectively reviewed the management and outcome of 36 failed VP shunts in pediatric patients for the treatment of hydrocephalus. The surgeries were performed between November 2010 and January 2016 in a tertiary care hospital. The minimal follow-up period was 3 months. We divided the patients into the following age groups: <1 year (eight infants), 1–10 years (18 children), and 10–18 years (10 children). The success of the procedure was determined by age, sex, type of hydrocephalus, and the number of shunt revisions and malfunction before ETV. Children with different age ($P = 0.839$) and sex group did not show any significant data ($P = 0.798$). Children with communicating hydrocephalus had a success rate of 52.9% (17 patients), and children with noncommunicating hydrocephalus had a success rate of 84.2% (19 patients). The success rate in children with only one shunt malfunction was 57.1% (21 patients), whereas in 15 children with two or more shunt malfunctions, the success rate of ETV was 86.7%. **Conclusions:** The authors conclude that ETV is an effective alternative for the treatment of hydrocephalus in children. Age does not present a contraindication for ETV in failed VP shunt.

Keywords: *Endoscopic third ventriculostomy, hydrocephalus, pediatric, ventriculoperitoneal shunt*

Introduction

The management of pediatric hydrocephalus is one of the most common clinical problems and the most challenging entities faced by the neurosurgeons of the 21st century. Shunts have traditionally been used for the treatment of both communicating and noncommunicating hydrocephalus, yet all shunt procedures are associated with the lifelong risk of shunt infection and their malfunction.[1,2] Forty percent of ventriculoperitoneal (VP) shunts done in children fail within 1st year of surgery.[3] Endoscopic third ventriculostomy (ETV) presents an alternative option to shunt insertion. Pediatric age groups (≥1–18 years) have a higher failure rate for ETVs compared with that of adult patients.[4,5] Having the different physiology of cranial development, intracranial compliance, and cerebrospinal fluid (CSF) production and absorption, findings from adult age group studies may not be applicable to pediatric patients.[6] The efficacy of primary ETV in obstructive hydrocephalus has led to high rates of shunt independence, ranging from 79% to 87.1%.[7] The use of ETV in the treatment of hydrocephalus in very young children, including those with communicating hydrocephalus, has been controversial.[8] The role of ETV in the management of hydrocephalus in the pediatric age group with failed VP shunt is less extensively studied. Considering the high long-term complication and revision rate of VP shunts, the expected lifelong shunt dependency, and the fact that most children indeed receive their shunt during the 1st year of life, we evaluated the role of ETV for the treatment of failed VP shunts in the pediatric age group.

Materials and Methods

The retrospective study was conducted in the Department of Neurosurgery, PGIMER and Dr. RML Hospital in the pediatric age group (≤18 years) between November 2010 and January 2016, and 36 children

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(24 boys and 12 girls) who presented with failed VP shunt with hydrocephalus were enrolled in this study. Detailed history, clinical examination, and investigation findings were noted. All enrolled patients underwent ETV with the removal of VP shunt at the time of the procedure, and the complications occurring during intraoperative and postoperative periods were recorded during the follow-up period at intervals of 2 weeks, 1 month, and 3 months, respectively. Depending upon the outcome of ETV in patients with shunt malfunction included in the study, the study population was divided into two groups: (1) patients with ETV success and (2) ETV failure. Data were analyzed for various factors likely to influence the success of ETV in pediatric patients with failed VP shunt. ETV success was defined as enduring shunt independence after the procedure.[9-11]

Results

The ETV procedure was successful in 25 patients (69.4%) and failed in 11 (30.6%) after a follow-up period of 3 months. The age of the patients included in the study was in the range of 2 months to 16 years and all divided into three groups. ETV was successful in patient ≤1 year (75%), in patient of 1–10 years (64.7%), and in patient of 10–18 years (80%) cases, respectively. The difference in the success rate in the three groups was not statistically significant ($P = 0.839$). ETV was successful in 71.4% males and 62.5% females with none statistically significant ($P = 0.798$) difference between sex group. Nine patients with communicating hydrocephalus (52.9%) and 16 patients with noncommunicating hydrocephalus (84.2%) were successfully treated by ETV. The difference in the success rate in both the groups was statistically significant ($P = 0.047$).

ETV success rate in children group was redistributed on the basis of subgroups based on the cause of hydrocephalus. In communicating hydrocephalus group, the causes for hydrocephalus in patients enrolled in our study were tuberculous meningitis (TBM), pyogenic meningitis, and postintraventricular hemorrhage. In noncommunicating group, the causes were congenital (aqueduct stenosis), tumor, and neurocysticercosis [Table 1]. Twenty-one patients who presented with VP shunt malfunction had only one shunt surgery done previously, whereas 15 patients had undergone two or more than two shunt revision surgeries before ETV. ETV was successful in 57.1% patients who had one shunt surgery prior to endoscopy procedure .Patients who had two or more shunt surgeries before ETV had success in 86.7% cases. The difference in two groups was not statistically significant ($P = 0.061$).

Distribution of patients according to anatomy, type, and size of the third ventricle

Endoscopic observations of third ventricular anatomy made during the procedure showed normal anatomy of the third ventricle in 21 patients and indistinct anatomy in 15 patients. About 71.4% of patients who had normal third ventricle anatomy observed during endoscopy had successful outcome, whereas 66.7% of patients who were having indistinct anatomy observed during the procedure had successful outcome. The difference between the two groups was not statistically significant ($P = 0.521$). Thickened third ventricle floor was found in 18 patients while performing ETV. About 61.1% of the patients with thickened third ventricle floor had successful outcome. Eighteen patients had normal third ventricle floor. About 77.8% of the patients in this group had a successful outcome after the procedure. The difference in two groups was not statistically significant ($P = 0.235$). Magnetic resonance imaging/computed tomography was performed in all the patients who had successful ETV after 3 months of surgery. In patients who had successful ETV; the ventricle size decreased in 9 patients (36%) while it remained the same in 16 patients (64%) on follow up MRI.

Distribution of patients according to prepontine cistern status

Adhesions in prepontine cistern were present in 7 patients, whereas it was clear in 29 patients. ETV success was reported in 75.9% of patients with clear prepontine cistern and in 85.7% of patients with adhesions in prepontine cistern. The difference in success was not statistically significant ($P = 0.291$).

Endoscopic findings [Table 2]

Rigid endoscopy revealed absent septum pellucidum in three patients, six patients had bulky choroid plexus, thickened floor of the third ventricle was seen in 18 patients, third ventricle anatomy was indistinct in 15 patients, adhesions were present in prepontine cistern in seven patients, tubercles were seen in seven patients, and Liliequist membrane was present in thirty patients. Bleeding was seen in four procedures. In three patients, bleeding was managed with irrigation and cautery. One patient was managed by VP shunt after the CSF cleared.

Discussion

The treatment of hydrocephalus in the form of VP shunt has been the gold standard in the last century. The risk of shunt malfunction is very high: 25%–40% failing the 1st year after shunt placement, 4%–5% per year after that, and 81% of shunted patients will require revision after 12 years. Therefore, it is presumed that shunt failure is almost inevitable during a patient's life.[12-14] It has also been noted that the incidence of shunt failure increases with the number of previous shunt failure.[15] To avoid long-term complications in shunt-dependent hydrocephalus, shunt removal during the third ventriculostomy is an ideal treatment that allows CSF circulation to return to a more normal level.

The primary ETV in obstructive hydrocephalus has proven to be effective, with an overall reported rate of shunt independency ranging from 79% to 87.1%.[16] Success rates in older children are comparable with adults. In our study, we included cases of both communicating and noncommunicating hydrocephalus with an overall success rate of 69.4%. The procedure was successful in 84.2% of noncommunicating hydrocephalus and 52.9% of communicating hydrocephalus. This result is comparable with the previous studies. Buxton *et al*.[17] reported a success rate of 73% in noncommunicating hydrocephalus and 46% in communicating hydrocephalus. In the literature review, ETV success in infants is lower as compared to older children. In our study, we found a success rate of 75% in <1 year age group. However, over the years, the success rate in infants has increased. In 2012, a study by Furlanetti *et al*.[18] showed a success rate of 58% in patients <6 months and a success rate of 65% in age 6 months to 1 year. The betterment in the success rate over the years may be due to improvement in the quality of the neuroendoscope, increased experience, and knowhow of the procedure. The etiology of the hydrocephalus is one of the most common considered factors predicting the success of ETV. In our study, aqueductal stenosis as a cause of hydrocephalus, with or without associated Dandy–Walker malformation, showed a success rate of 80% for secondary ETV. This is comparable with previous studies. Furlanetti *et al*.[18] reported that ETV was successful in 88% of cases of aqueductal stenosis in children. O'Brien *et al*.[12] reported a success rate of 68% with the patients having aqueductal stenosis. A success rate of 100% was observed in our study, for cases of ETV done in postintraventricular bleed with hydrocephalus, posterior fossa tumors, and fourth ventricle neurocysticercosis.

Furlanetti *et al*.[18] reported a success rate of 90% in cases of tumors and a rate of 60% in cases of post-IVH. In our study, post-TBM hydrocephalus was associated with 54.54% success rate. This rate is at par with the rate ranging from 41% to 81% reported by studies.[19,20] The low success rate in post-TBM hydrocephalus can be due to less number of enrolled patients.

In our study, we found a success rate of 40% in postpyogenic meningitis. Fukuhara *et al*.[21] had a success rate of 25%. Lee *et al*.[14] 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, the success rate in noncommunicating hydrocephalus was more than the success rate in communicating hydrocephalus and was statistically significant. The shunt hardware was removed in all cases at the time of ETV with the ventricular end being removed under vision to detect any IVH during removal. This was done with the rationale that the shunt hardware will act as a foreign body and as a source of infection. Furthermore, it has been argued that the intermittent or remaining flow through a malfunctioning shunt may cause reduced flow through the stoma itself and consequently may promote its closure contributing to ETV failure. The risk of ETV failure as compared to VP shunt failure becomes progressively lower after about 3 months.[22] Hence, we had taken 3-month follow-up in our study.

Table 1: Etiology of hydrocephalus

Type	Etiology	Success	Failure
Communicating Hydrocephalus	Tuberculous Meningitis	06	05
	Post Pyogenic	02	03
	Post Intraventicular hemorrhage	01	00
Noncommunicating Hydrocephalus	Congenital (Aqueduct stenosis)	12	03
	Tumour	02	00
	Neurocysticercosis	02	00

Table 2: Endoscopy Findings

Findings	Number
Absent Septum Pellucidum	03
Bulky Choroid Plexus	06
Indistinct third ventricle anatomy	15
Thickened third ventricle floor	18
Tubercles	07
Adhesion in prepontine cistern	07
Liliequest membrane	30

We observed a complication rate of 13.9% with the procedure which required an external ventricular drain placement. This complication rate is in accordance with other studies in the literature which report a rate of 6%–14% in experienced hands.[9]

Cinalli *et al*.[23] measured ICP in early postoperative days and investigated the role of lumbar punctures to allow faster normalization of the ICP, suggesting a cycle of one to three lumbar punctures being performed before assuming that ETV failed in patients who remain symptomatic and show ventricular dilatation after ETV. In our study, we did spinal taps for 3 consecutive days in all patients who underwent the procedure.

Conclusions

ETV is a viable and good alternative to the traditional shunt revisions in pediatric patients presenting with shunt malfunction. ETV is a technically demanding procedure with a longer learning curve. However, in experienced hands, it can spare the patient from lifelong risks of shunt surgery. A larger study with a longer follow-up will help in determining the role of ETV in pediatric patients presenting with failed VP shunt.

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Conflicts of interest

There are no conflicts of interest.

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