

## Endoscopic Third Ventriculostomy in Children with Failed Ventriculoperitoneal Shunt

### Abstract

**Context:** Endoscopic third ventriculostomy (ETV) is an accepted procedure for the treatment of obstructive hydrocephalus. The role of endoscopic treatment in the management of shunt malfunction was not extensively evaluated. The aim of this study is to evaluate the success rate of ETV in pediatric patients formerly treated by ventriculoperitoneal (V-P) shunt implantation. **Materials and Methods:** Thirty-three patients with their first shunt failure and obstructive hydrocephalus in brain imaging between 2008 and 2014 were enrolled in this study. **Results:** The most common causes of hydrocephalus in these patients were aqueductal stenosis and myelomeningocele with or without associated shunt infection. Of these 33 cases, 20 ETV procedures were successful, and 13 cases needed shunt revision after ETV failure. There was no serious complication during ETV procedures. The follow-up period of patients with successful ETV was 6–50 months (mean 18 months). The time interval between ETV and new shunting subsequent to ETV failure was 24.4 days (10–95). **Conclusions:** ETV can be considered as an alternative treatment paradigm in patients with previous shunt or new shunt failure with an acceptable success rate of 60%, although long-term follow-up is needed for these patients.

**Keywords:** Endoscopic third ventriculostomy, revision, shunt

### Introduction

Endoscopic third ventriculostomy (ETV) is an accepted procedure for the treatment of non-communicating hydrocephalus. The success rate of ETV has been reported to be up to 90% in cases of aqueduct stenosis or fourth ventricle outflow obstruction. In spite of using ETV in patients with communicating hydrocephalus, it has a higher failure rate comparing to obstructive hydrocephalus. However, ventriculoperitoneal (V-P) shunting is still a prevalent procedure for treatment of different types of hydrocephalus specifically communicating ones.<sup>[1,2]</sup>

Most patients with shunt malfunction and or infection are treated with shunting procedure, but ETV can be used as an alternative treatment in some of these patients to control intracranial hypertension. The role of endoscopic management of hydrocephalus in shunt malfunction was not investigated extensively so far. There are several studies which have considered ETV as the main treatment of hydrocephalus in

patients with shunt failure.<sup>[3-6]</sup> Therefore, this is an attractive topic in neurosurgery especially in pediatric neurosurgery that can work and make a different kind of studies with diverse power to explore the role of ETV after shunt failure.

Here, we have retrospectively studied the files of our patients with first shunt failure which were treated with ETV and subsequently evaluated the result of ETV.

### Materials and Methods

There were 33 pediatric patients whom underwent ETV instead of V-P shunt revision for the primary V-P shunt failure from 2008 to 2014.

All patients with shunt failure and obstructive hydrocephalus in brain Magnetic resonance imaging (MRI) admitted for shunt malfunction and/or infection were included in this study. Ethical approval was received from the Children's Hospital Center Ethics Committee. The exclusion criteria of this study were children in coma or posturing state, those with very small size ventricles, those who were unable to perform brain

**Bijan Heshmati,  
Zohreh Habibi<sup>1</sup>,  
Mehdi  
Golpayegani<sup>2</sup>,  
Farhad Salari<sup>2</sup>,  
Mousarreza  
Anbarlouei<sup>1</sup>,  
Farideh Nejat<sup>1</sup>**

*Department of Neurosurgery, Imam Reza Hospital, Urmia, <sup>1</sup>Department of Neurosurgery, Children's Medical Center Hospital, Tehran University of Medical Sciences, <sup>2</sup>Department of Neurosurgery, Shahid Beheshti University of Medical Science, Tehran, Iran*

**Address for correspondence:**  
Prof. Farideh Nejat,  
Children's Hospital Medical  
Center, Gharib Street  
141557854, Tehran, Iran.  
E-mail: nejat@sina.tums.ac.ir

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MRI, and those who did not have a sufficient space anterior to the basilar artery.

The endoscope used in our series was Aesculap® rigid endoscope. In most cases, a thin floor could be observed, and the ventriculostomy was performed at the standard location between infundibular recess and mammillary bodies in front of the basilar artery. In some cases, there was the thick floor, but the procedure was not abandoned. Fenestration could successfully be done through touching the floor with a blunt applicator. When we could confirm dorsum sellae through the thick floor by finding the bony feeling, floor perforation was safely performed just posterior and adjacent to dorsum sella.

ETV failure was considered whenever a child has needed more surgery for the management of persistent hydrocephalus subsequent to ETV. The patients were followed in the outpatient clinic regularly 2 weeks, 2 months, and 6 months after ETV procedure and then every 6 months. If any symptoms of persistent hydrocephalus were found after ETV, shunt revision or new V-P shunting was performed. In seven cases of ETV failures, Cine MRI was performed. Brain Cine MRI was planned 6 months after the surgery in patients who were asymptomatic after ETV.

All patients were followed for at least 6 months except for patients who found ETV failure earlier than 6 months. The follow-up period was 6–50 months (mean 18 months) at the time of this study. All cases with ETV failure were managed with shunting procedure.

## Results

There were 22 boys (67%) and 11 girls (33%), with their age ranging between 5 months to 13 years (mean = 4.5 years) at the time of first shunt failure. The most common cause of hydrocephalus was aqueductal stenosis ( $n = 22$ ) followed by myelomeningocele ( $n = 6$ ), Dandy–Walker syndrome ( $n = 2$ ), premature IVH ( $n = 1$ ), tumor ( $n = 1$ ), and meningitis ( $n = 1$ ). All patients had obstructive hydrocephalus in their brain MRI, but according to the primary etiology the population was not homogeneous; 31 had a kind of obstructive hydrocephalus, and only 2 had predominantly communicating hydrocephalus as the first cause of their hydrocephalus which needed shunt surgery.

Time interval between the first shunt surgery and the first shunt failure was between 4 months to 12 years (mean = 3.4 years). Of 33 cases of first V-P shunt failure, there were 16 children with shunt failure secondary to shunt infection and 17 cases due to shunt malfunction [Table 1].

Signs and symptoms of raised intracranial hypertension (including headache, increased head circumference, tense fontanel, vomiting, and papilledema) were noted in the majority (31) of the cases. The seizure was seen in two cases and more motor regression in another 2.

Of 33 children included in this study, 20 cases did not require further procedure so far, because the ETV was functional and effective. During postoperative assessments, 13 patients required new ventricular shunt approach within a mean period of  $24.4 \pm 22.7$  days (10–95) from the endoscopic procedure. The follow-up period for children who did well without any need to further intervention was 6–50 months (mean of  $18.05 \pm 10.22$  months).

The overall success rate of ETV was 60.6%. The highest success was achieved in myelomeningocele 66.6% (4 of 6 patients) and aqueductal stenosis cases 63.6% (14 out of 22 cases). The prematurity IVH and meningitis cases had the least as all of them managed later with new VP shunting. However, the difference between the cause of hydrocephalus and successful ETV was statistically nonsignificant ( $P = 0.56$ ). It can be related to the small sample size and various etiologies. ETV was not successful in 13 cases (39.4% of cases which were later treated by V-P shunting procedure).

During the interval between ETV procedure and functional resolution of hydrocephalus, the shunts were left in its place in cases of malfunction. In patients with shunt infection first the shunt was removed, and wide spectrum antibiotics were prescribed. Intracranial hypertension was managed with external ventricular catheter insertion in patients with closed fontanel or with regular ventricular tapping in others with open fontanel (fontanel was monitored regularly according to being soft or bulge; whenever, it was bulge ventricular tap was performed).

There were no serious complications in any of our 33 patients, although there were temporary electrolyte disturbances in 10 patients, low-grade fever in 8 and

**Table 1: Data related to cause of hydrocephalus, associated shunt infection and the success of endoscopic third ventriculostomy during the follow-up**

Cause of hydrocephalus	<i>n</i> (percent)	Associated shunt infection ( <i>n</i> )	ETV success ( <i>n</i> )	New shunt ( <i>n</i> )
Aqueductal stenosis	22 (66.6%)	12	14	8
Myelomeningocele	6 (18%)	1	4	2
Dandy Walker syndrome	2 (6%)	1	1	1
Prematurity hemorrhage	1 (3%)	0	0	1
meningitis	1 (3%)	0	0	1
Tumor	1 (3%)	1	1	0

cerebrospinal fluid (CSF) leakage in 5 of our patients which was managed by lumbar puncture and two of them needed shunting later.

## Discussion

The treatment of different types of hydrocephalus including communicating and non-communicating hydrocephalus has traditionally been through the insertion of a shunting device, usually a V-P or ventriculoatrial shunt. The development of neuroimaging and less invasive surgeries have changed the treatment of hydrocephalus. Nowadays, ETV is a good choice for the treatment of obstructive/noncommunicating hydrocephalus with success rates of up to 90% in cases of aqueductal stenosis.<sup>[2]</sup> ETV has helped the hydrocephalic patient from the shunt dependency and its complications as a foreign body.

Comparing ETV to V-P shunt, there are some advantages for ETV including restoration of physiological CSF circulation, the absence of foreign material, lower rate of infection, and decreased incidence of late complications.<sup>[2,3]</sup> The efficacy and success rate of ETV in patients whose primary shunt has failed, however, has been a matter of debate.<sup>[5-9]</sup>

ETV complications have been reported to be higher in patients with previous V-P shunts during the procedure and so postoperatively.<sup>[6,10,11]</sup> ETV failure has been pointed out to be 2.5 times greater in patients with previous shunt and even death as a consequence of ETV failure has been reported.<sup>[7,8]</sup> Some authors have kept ventricular catheter with a reservoir or Ommaya reservoir subsequent to ETV surgery in previously shunted patients with acute V-P shunt dysfunction.<sup>[9,10]</sup> Temporary external ventricular drainage after ETV surgery in these patients has been advised too.<sup>[11,12]</sup> In our series, all ETV failures occurred in the first 3 months, but late failure with even catastrophic results can occur in 2%–15% of patients who underwent ETV to treat shunt malfunction symptomatology.<sup>[3,11,12]</sup> Therefore, ETV failure should be kept in mind during clinical follow-up of these patients and even delayed ETV failure must be mentioned to the parents and patients to prevent any late catastrophic event.<sup>[13]</sup>

In this series, the best ETV success rate was achieved in cases with congenital aqueductal stenosis and myelomeningocele patients that is similar to the results of some other reports.<sup>[9-11]</sup>

There are several risk factors contributing to more failure rate of ETV: The type of hydrocephalus, the time course of symptoms leading to ETV, and previous implantation of a V-P shunt.<sup>[9]</sup> The previous V-P shunt implantation with overdrainage manifestations may cause reduced ventricular wall compliance; thus, it leads to the elimination of compensation mechanisms during acute intracranial hypertension.<sup>[8,14]</sup>

This assumption that a working V-P shunt decreases the CSF resorption capacity after a few years influences on the outcome of ETV used for shunt failure management. Furthermore, the success rate of ETV in patients with previous V-P shunt implantation is comparable to the success rate of primary ETV.<sup>[4,13]</sup>

It has been reported that ETV failure in shunted patients occurs during a longer time period compared with primary ETV as the first treatment in hydrocephalus patients.<sup>[6]</sup> Different success rates have been reported for ETV for management of shunt failure (65% in adults, 70% and 82% in children).<sup>[5,7,13,14]</sup> The success rate of ETV in our series as an alternative to shunt revision was about 60% which is lower than reported rates in pediatric populations.

## Conclusions

ETV can be considered in previously shunted patients presenting with shunt failure. The success rate was around 60% in pediatric patients of our series. The parents should be informed about the possibility of complications and failure of ETV. The long-term follow-up is required to diagnose and treat the early and late failure of ETV in these children.

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## Conflicts of interest

There are no conflicts of interest.

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