# Endoscopic Third Ventriculostomy: Outcome Analysis of 40 Consecutive Cases

## Endoskopik Üçüncü Ventrikülostomi: 40 Olguluk Serinin Sonuçları

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Received: 23.10.2002 ⇨ Accepted: 23.01.2003

**Abstract:** Giving opportunity to avoid placement of shunt systems, endoscopic third ventriculostomy (ETV) has revolutionized the management of hydrocephalus. With increasing experience, indications for ETV are being continuously reviewed and expanded. We report a retrospective analysis of our experience with 40 consecutive patients who have undergone ETV procedure in the past 5 years. The patient population was heterogeneous, ranging in age from 4 weeks to 67 years, with a variety of diagnoses. We reviewed controversial issues regarding this procedure, including age and indications.

**Key Words:** Endoscopic third ventriculostomy, hydrocephalus, indications, outcome.

**Özet:** Hastayı şanttan kurtarma şansı tanıyan, endoskopik üçüncü ventrikülostomi prosedürü, günümüz hidrosefali cerrahisinde yeni bir çığır açmıştır. Giderek artan deneyimler, bu prosedürün endikasyon yelpazesinin daha ayrıntılı olarak incelenmesi ve genişletilmesini beraberinde getirmektedir. Bu yazıda, son 5 sene içerisinde endoskopik üçüncü ventrikülostomi uyguladığımız 40 olguluk seriye ait deneyim ve sonuçlarımız sunulmuştur. Seriyi oluşturan hastalar, yaşları 4 hafta ile 67 yıl arasında değişen, ve çeşitli tanı gruplarına ait heterojen bir gruptur. Yazıda, ayrıca endoskopik üçüncü ventrikülostomi prosedüründe yaş ve endikasyonlar gibi halen tartışılmakta olan konular da ayrıntılı literatür bilgisi ışığında gözden geçirilmiştir.

**Anahtar Sözcükler:** Endikasyonlar, endoskopik üçüncü ventrikülostomi, hidrosefali, sonuç.

## INTRODUCTION

Endoscopic third ventriculostomy (ETV) is currently the principal alternative to cerebrospinal fluid shunt placement in the management of hydrocephalus. Since its reintroduction during the last 2 decades, ETV has shown promising results. Today, ETV is the procedure of choice for patients with obstructive hydrocephalus with the success rate reaching 60 to 85% in reported series (7, 9, 15,). With increasing experience, indications for ETV are being continuously reviewed and expanded (16).

In our center ETV is the first-line treatment for noncommunicating hydrocephalus. We also attempt ETV initially in patients with hydrocephalus following intraventricular or subarachnoid hemorrhage, and cerebrospinal fluid (CSF) infections, in hydrocephalic children associated with myelomeningocele, and in patients presenting with shunt failure who are anatomically suitable, having cerebrospinal fluid spaces large enough to admit the endoscope.

In this report we detail our experience on 40 consecutive cases who had undergone ETV between 1997 and 2002. In this retrospective analysis, patients were reviewed for age at the time of operation, preoperative diagnosis, preoperative CSF diversion procedures, preoperative history of CSF infection or hemorrhage, success or failure of the ETV, and complications. We also reviewed the controversial issues regarding this procedure, including timing and indications.

## MATERIALS AND METHODS

A retrospective review was performed on 40 consecutive cases of ETV performed at Kocaeli University Faculty of Medicine Department of Neurosurgery Neuroendoscopy Unit between 1997 and 2002.

This series were consisted of 22 male and 18 female patients with a mean age of 20,7 (±3,5 SEM) years (range 4 weeks to 67 years), 13 of whom had ventricular CSF diversions at the time of ETV, 8 having permanent CSF shunts.

As well as the patients in whom magnetic resonance imaging (MRI) revealed a noncommunicating hydrocephalus with the obstruction in the posterior aspect of or distal to the third ventricle, also the patients who suffered hydrocephalus following intraventricular / subarachnoid hemorrhage or CSF infection, children suffered hydrocephalus with associated Chiari/myelomeningocele, and the patients who experienced shunt failure were included. 32 procedures were done as primary treatment of hydrocephalus and 8 procedures for shunt failure.

Patient records were reviewed to establish age at the time of operation, etiology of hydrocephalus, preoperative shunt or external ventricular drainage (EVD) procedures, history of CSF infection or hemorrhage, success or failure of the ETV, and complications.

The definition of "ETV failure" was based on a pragmatic, practical standard that was used in a international multicenter retrospective study: either the patients needed a shunt inserted after attempted ETV, or they didn't (16).

All ETVs were performed with similar technique using freehand method. A O° rigid rod lens neuroendoscope with an outher diameter of 4,0 mm (Karl Storz GmbH & Co., Tuttlingen, Germany) was used. All operative procedures were done with video imaging (Karl Storz Telecam, SL) and were recorded. The perforation of the floor of the third ventricle was ideally placed into the tuber cinereum between the infundibular recess of the pituitary stalk and the anterior border of the mammillary bodies to enter the interpeduncular cistern and to avoid injury of the basilar apex. Fenestration of the floor of the third ventricle was accomplished with monopolar coagulation and dilated by inflating a 4 French balloon catheter. Any thickened and diffuse arachnoidal trabeculations and webs in the interpeduncular cistern were also opened successfully with blunt dissection of the monopolar coagulation probe until a free communication along the basilar artery was visualized. (Figures 1, 2 and 3). Ringer's solution with temperature of 37°C was used for irrigation. Any CSF diversion system was immediately removed to prevent closure of the stoma.

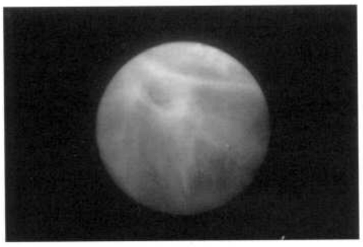

Figure 1: Neuroendoscopic view of thickend and diffuse aracnoidal trabeculations and webs in the interpeduncular cistern.

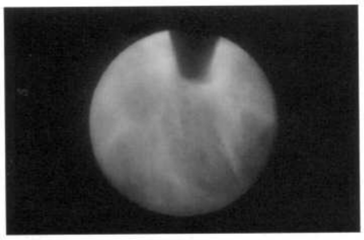

Figure 2: Secondary arachnoidal trabeculations in the interpeduncular cistern were opened with blunt dissection of the monopolar coagulation probe.

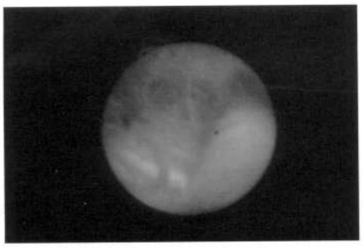

Figure 3: A free communication along the basilar artery was achieved after dissecting the aracnoidal webs in th interpeduncular cistern.

## RESULTS

The etiology of hydrocephalus in this series of 40 patients is grouped in Table 1, which also notes the success rates for these groups. There was a high success rate (>85%) for diagnosis relating to mechanical obstruction of the CSF flow; this was due variously to aqueductal stenosis, posterior fossa mass, posterior fossa hematoma, and third ventricle mass.

The age of the patients are grouped in Table 2. Children under the age of 2 seem to fail ETV more often (44,5%) than older patients (22,6%). However, these results are not statististically significant (P>0.05, Pearson Chi-square test).

Table 3 shows the preoperative CSF diversion status prior to ETV and outcome. Patients who had a permanent malfunctioning CSF shunt in place at the time of ETV were less likely to benefit (62,5%) than those with an EVD (80%) or no shunting device at all (74%), although these results are not statististically significant (P>0.05, Pearson Chi-square test).

Table 4 shows the history of CSF infection or hemorrhage prior to ETV and outcome. In our series, 6 of 12 patients (50%) who suffered from meningitis / ventriculitis or shunt infections and 4 of 6 patients (66,6%) who experienced intraventricular or subarachnoid hemorrhage became shunt-free or experienced improved conditions after ETV. The only patient in this series with a history of both CSF infection and intraventricular hemorrhage failed ETV and remained shunt-dependent.

Of the 11 patients (27,5%) in whom ETV procedure failed, 3 ETV procedures were abandoned owing to unsuitable anatomical features. In one of these cases the entry of foramen Monro was partially obliterated with a vascular web. The entry of foramen Monro was extremely narrow in another case. In the third one, we had to abandon the procedure because of a prominent massa intermedia.

Of the 8 cases (20%) in which ETV procedure was completed but failed, 5 failed within the first several days of surgery. The remaining 3 failed 1, 3, and 4 months after ETV. These 3 patients underwent repeat ETVs. Only in one patient closure of the ostomy site was observed. In the first procedure we had experienced a shallow and highly vasculature prepontine cistern in that patient, so refenestration was not performed through the opacified tuber cinereum due to relatively high risk of vascular damage.

Table 1: Patients are grouped according to the etiology of hydrocephalus. Number of patients and success rates are shown.

| Etiology of Hydrocephalus | No. of Cases ETVs | No. of successful | Percent Success |
|---|---|---|---|
| Aqueductal stenosis | 7 | 6 | 85,7 % |
| Posterior fossa mass | 1 | 1 | 100 % |
| Posterior fossa hematoma | 4 | 4 | 100 % |
| Third ventricle mass | 4 | 4 | 100 % |
| Meningomyelocele | 5 | 3 | 60 % |
| Hydrocephalus following meningitis / ventriculitis | 9 | 5 | 55,5 % |
| Hydrocephalus following Intraventricular or subarachnoid hemorrhage | 7 | 4 | 57 % |
| Congenital hydrocephalus | 3 | 2 | 66,6 % |

Table 2: Patients are grouped according to the age. Number of patients and success rates are shown.

| Age | No. of Cases | No. of successful ETVs | Percent Success |
|---|---|---|---|
| Less than 2 Years | 9 | 5 | 55,5 % |
| 2 Years and older | 31 | 24 | 77,4 % |

Table 3: Patients are grouped according to the preoperative CSF diversion status prior to ETV. Number of patients and success rates are shown.

| Preoperative CSF Diversion | No. of Cases | No. of successful ETVs | Percent Success |
|---|---|---|---|
| EVD | 5 | 4 | 80 % |
| Shunt | 8 | 5 | 62,5 % |
| None | 27 | 20 | 74 % |

Table 4: Patients are grouped according to the history of CSF infection or hemorrhage prior to ETV. Number of patients and success rates are shown.

| Preoperative History | No. of Cases | No. of successful ETVs | Percent Success |
|---|---|---|---|
| Patients with a history of CSF infection (meningitis, ventriculitis, or shunt infection) | 12 | 6 | 50 % |
| Patients with a history of IVH or subarachnoid hemorrhage only | 6 | 4 | 66,6 % |
| Patients with a history of both CSF infection and IVH or subarachnoid hemorrhage | 1 | 0 | 0 % |

There were two cases of intraoperative bleeding. Both were self-limited and cleared with irrigation. These two patients had temporary external ventricular drains (EVD) inserted following ETV. There were no permanent morbidities and no mortalities in our series. The overall success rate for ETV in this series was 72,5%. All of the 11 cases that failed ETV subsequently have undergone shunt surgery.

## DISCUSSION

Hydrocephalus is still one of the major challenges in modern neurosurgery. Despite sophisticated developments in shunt systems, numerous revisions for malfunctioning and infected shunts are still encountered in neurosurgical practice. To eliminate shunt systems in the treatment of hydrocephalus, different alternative techniques have been applied over the years, including Torkildsen's ventriculocisternotomy, microsurgical opening of the floor of the third ventricle or the lamina terminalis, and stereotactic perforation of the floor of the third ventricle (5). Combining a minimally invasive approach with visual control of the manipulations, ETV is accepted to be the best technique presently as an alternative to shunt systems in the treatment of hydrocephalus.

After its reintroduction, the indication for ETV was restricted to noncommunicating hydrocephalus. By many authors, the success of ETV in the treatment of hydrocephalus was reported to depend largely on appropriate patient selection. Scarrow et al. noticed that, for ETV procedure to be successful, two conditions should be present preoperatively in candidates for the operation: 1) a significant obstruction of the flow of CSF between the ventricles and the subarachnoid space 2) preservation of CSF absorption from the subarachnoid space into the venous system (15).

To determine which patient groups have the highest chance of successful ETV, several retrospective case reviews were performed (1, 7, 9, 15). Performing an outcome analysis on 97 patients who underwent ETV, Brockmeyer et al. reported that the highest success rates were achieved in patients with aqueductal stenosis, tectal plate tumor, myelomeningocele and posterior fossa tumor (1). Reviewing 100 consecutive ETV procedures, Hopf et al. noticed that the patients with benign space-occupying lesions and nontumorous aqueductal stenosis had the highest success rates (9). In their review on 125 patients who underwent ETV for obstructive hydrocephalus, Gangemi et al.reported higher rates of good postoperative results in primary aqueductal stenosis and triventricular hydrocephalus due to external compression (7). Scarrow et al. performed a retrospective chart review on 54 patients who had undergone ETV and reported that children over the age of 3 years with an acquired CSF obstruction had a significantly greater probability of success with ETV (15).

In our series, there was a high success rate (>85%) of ETV for diagnosis relating to mechanical obstruction of the CSF flow (aqueductal stenosis, posterior fossa mass, posterior fossa hematoma, and third ventricle mass), which was concordant with previously reported series.

Patients with a history of CSF infection, shunt infection, intraventricular / subarachnoid hemorrhage, and pediatric patients with associated spinal dysraphism have been considered by many authorities to be prone to treatment failure (6, 14, 18). Whether ETV is an alternative for the treatment of this group of hydrocephalic patients is still a matter of debate. A number of recent reports indicated that ETV was, to a certain extent, also successful in this group of patients (8, 17). In a recent multicenter retrospective study, Siomin et al. reported that ETV might play a significant role in the treatment of patients with a history of either infection or hemorrhage, with efficacy comparable to more general series of patients with obstructive hydrocephalus (16).

Several hypothetical explanations were made in order to explain the success of ETV in this group of patients (9, 16): 1) A combination of obstruction and impaired CSF reabsorption is responsible for hydrocephalus in these patients. ETV may then enable access to previous inaccessible and possibly not impaired CSF reabsorption areas. 2) The subarachnoid space is capable of developing and adapting to altered CSF dynamics, finally leading to an increase in reabsorption. 3) The CSF absorption system either recovers with time, or may stay patent despite the insults of bleeding, infection, or long disuse. 4) The sequence of fibrosis and thickening of leptomeninges and consequent obliteration of the subarachnoid may be reversible.

In our series, 6 of 12 patients (50%) who suffered from meningitis / ventriculitis or shunt infections and 4 of 6 patients (66,6%) who experienced intraventricular or subarachnoid hemorrhage became shunt-free or experienced improved conditions after ETV. Our results seem to support the conclusions of the study that Siomin et al. reported (16).

In our series we also reviewed the effect of preoperative CSF diversion status on outcome. Patients having a permanent malfunctioning CSF shunt in place at the time of ETV seemed less likely to benefit than those with an EVD or no shunting device at all. But we did not find any statististically significant difference between these groups. This finding is similar to the one that Scarrow et al. reported (15).

ETV was thought to be contraindicated in patients with reduced CSF reabsorption capacity, which may be seen in hydrocephalus associated with spinal dysraphism (18). In contrast to this assumption, a publication on patients with spinal dysraphism and ETV reported success rates of more than 70% (17). In our series, 3 (60%) of 5 children with myelomeningocele experienced successful ETV. We believe that offering ETV to these patients is worthwhile. However, one must be cautious for the anatomical variations of the foramen Monro and the third ventricle, which are frequently encountered in myelodysplastic patients.

The optimal time to perform ETV in pediatric population is another matter of debate. Controversy exists regarding whether children under 2 years of age have a higher risk of treatment failure after neuroendoscopic procedures for the treatment of hydrocephalus than older children. Most authors reported that ETV was significantly more effective in pediatric patients who are older than 2 years of age (4, 12, 13, 14). However, some experts advocate attempting ETV as a first line of treatment in infants, despite a modest success rate (2, 3). Jones et al. reported a successful ETV in a 1200 gram weighted premature patient (11). Javadpour et al. suggested that the selective use of ETV as the primary treatment in infants with hydrocephalus was safe and could lead to a reduction in the shunted population of all newly diagnosed hydrocephalic infants by up to 21%. They stated that success of ETV was etiology, not age dependent (10).

In our series, 9 of 40 patients (22,5%) were younger than 2 years of age and 5 (55,5 %) of these patients experienced successful ETV. We do not support the statement that success rates may be higher if only pediatric patients older than 2 years of age are selected for ETV (11). We believe that the chance of a shunt-free life should not be denied to pediatric patients less than 2 years of age.

In our series of 40 ETVs, there were no permanent morbidities and no mortalities. Potential further complications of ETV, which did not occur in our series, are injury to the basilar artery, hemiparesis, third nerve palsy, and hypothalamic dysfunction (9). Potential complications of ETV procedure are more serious compared with shunt surgery, but increased experience with the procedure keeps fatal risks quite rare. However, shunting has much more potential to result in serious morbidity and mortality in the long run.

## CONCLUSION

In conclusion, our results indicate that ETV is highly effective in uncomplicated occlusive hydrocephalus. ETV is also effective in approximately 52 % of patients with previous infections or intraventricular bleeding. Also 55,5 % of pediatric patients younger than 2 years of age enjoyed a successful ETV and became shunt-free.

ETV, if performed correctly, is an effective treatment option for hydrocephalus. With growing experience, the indications for ETV are being continuously expanded. The major advantage of this procedure is the elimination of the various complications that are associated with shunt systems. As an opportunity to become shunt-free, we offer ETV to all hydrocephalic patients meeting the contemporary criteria of indications for this procedure. With any successful ETV, many operations and hospitalizations will be prevented.

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## REFERENCES

1. Brockmeyer D, Abtin K, Carey L, Walker ML: Endoscopic third ventriculostomy: an outcome analysis. Pediatr Neurosurg 28; 236-40, 1998
2. Buxton N, Macarthur D, Mallucci C, Punt J, Vloeberghs M: Neuroendoscopic third ventriculostomy in patients less than 1 year old. Pediatr Neuro-surg 29; 73-76, 1998
3. Buxton N, Macarthur D, Mallucci C, Punt J, Vloeberghs M: Neuroendoscopy in the premature population. Childs Nerv Syst 14; 649-652, 1998
4. Cinalli G: Alternatives to shunting. Childs Nerv Syst 15; 718-731, 1999
5. Dalrymple SJ, Kelly PJ: Computer-assisted stereotactic third ventriculostomy in the management of noncommunicating hydrocephalus. Stereotact Funct Neurosurg 59; 105-110, 1992.
6. Fukuhara T, Vorster SJ, Luciano MG: Risk factors for failure of endoscopic third ventriculostomy for obstructive hydrocephalus. Neurosurgery 46; 1100-1109, 2000
7. Gangemi M, Donati P, Maiuri F, Longatti P, Godano U, Mascari C: Endoscopic third ventriculostomy for hydrocephalus. Minim Invasive Neurosurg 42; 128-132, 1999
8. Grant JA, McLone DG: Third ventriculostomy: A review. Surg Neurol 47; 210-212, 1997
9. Hopf NJ, Grunert P, Fries G, Resch KD, Perneczky A: Endoscopic third ventriculostomy: outcome analysis of 100 consecutive procedures. Neurosurgery 44; 795-804, 1999
10. Javadpour M, Mallucci C, Brodbelt A, Golash A, May P: The impact of endoscopic third ventriculostomy on the management of newly diagnosed hydrocephalus in infants. Pediatr Neurosurg 35; 131-135, 2001
11. Jones RF, Teo C, Stening WA, Kwok BC: Neuroendoscopic third ventriculostomy, in Manwaring KH, Crone KR (eds), Neuroendoscopy, volume 1, New York: Mary Ann Liebert, 1992: 63-77
12. Jones RF, Kwok BC, Stening WA, Vonau M: The current status of endoscopic third ventriculostomy in the management of non-communicating hydrocephalus. Minim Invasive Neurosurg 37; 28-36, 1994
13. Jones RF, Kwok BC, Stening WA, Vonau M: Neuroendoscopic third ventriculostomy: A practical alternative to extracranial shunts in non-communicating hydrocephalus. Acta Neurochir Suppl (Wien) 61;79-83, 1994
14. Sainte-Rose C: Third ventriculostomy, in Manwaring KH, Crone KR (eds), Neuroendoscopy, volume 1, New York: Mary Ann Liebert, 1992: 47-62
15. Scarrow AM, Levy EI, Pascucci L, Albright AL: Outcome analysis of endoscopic III ventriculostomy Child's Nerv Syst 16; 442–445, 2000
16. Siomin V, Cinalli G, Grotenhuis A, Golash A, Oi S, Kothbauer K, Weiner H, Roth J, Beni-Adani L, Pierre-Kahn A, Takahashi Y, Mallucci C, Abbott R, Wisoff J, Constantini S: Endoscopic third ventriculostomy in patients with cerebrospinal fluid infection and/or hemorrhage. J Neurosurg ; 97; 519-24, 2002
17. Teo C, Jones R: Management of hydrocephalus by endoscopic third ventriculostomy in patients with myelomeningocele. Pediatr Neurosurg 25; 57-63, 1996
18. Vries JK, Friedmann WA: A quantitative assessment of CSF re-absorption in infants with meningomyelocele. Surg Neurol 13; 38-40, 1980