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ORIGINAL PAPER

# Endoscopic third ventriculostomy in children younger than 2 years of age

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**Abstract**
*Introduction* Endoscopic third ventriculostomy (ETV) for the treatment of hydrocephalus of different etiologies is still controversial in children younger than 2 years of age. The success rate of ETV in this group of patients is analyzed in this study.
*Materials and methods* The series consisted of 21 patients treated with ETV. The mean age of the patients was 6.7 months, ranging from 9 days to 15 months (16 patients were younger than 1 year). The study included hydrocephalus due to idiopathic aqueductal stenosis (eight) and other congenital anomalies (four) as well as posthemorrhagic (three) and tumor-related occlusive hydrocephalus (three). Two patients presented with shunt infection and one with a shunt failure. ETV was considered to be successful when shunting could be avoided.
*Results* ETV was successful in nine patients, with a mean follow-up period of 26.2 months. The procedure was successful in four patients with idiopathic aqueductal stenosis, in two with other congenital anomalies, in one posthemorrhagic, and in two with a tumor-related hydrocephalus. In 12 patients, the ETV was unsuccessful after a mean follow-up of 3.3 months. These patients required a shunt. Ten of them were less than 1 year old when ETV was performed. In one tumor-related hydrocephalus, a shunt was inserted after a meningitis after tumor removal.
*Conclusions* The success of ETV in children younger than 2 years of age suffering from non-communicating hydrocephalus seems to be dependent on both age and etiology. Our results show an overall success rate of 43%. In 37.5% of the children younger than 1 year of age, ETV was successful. ETV in patients with hydrocephalus due to idiopathic aqueductal stenosis seems to be more beneficial than in other causes of hydrocephalus.

**Keywords** Endoscopic third ventriculostomy · Hydrocephalus · Children

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## Introduction

Endoscopic third ventriculostomy (ETV) has already become the therapy of choice for the treatment of non-communicating hydrocephalus [1–5]. The experiences with ETV in adults are continuously increasing and reveal a favorable outcome for most of these patients [6–10]. However, the success rate differs in very young children from older patients. In children younger than 2 years of age and particularly in infants, controversies exist whether ETV might be superior to shunt placement or not. Most studies report a lower success rate of ETV in this group of patients [11–14]). There is an ongoing discussion whether age or etiology of the hydrocephalus or both influence the outcome [15–19]. In our retrospective study, we analyzed the data of 21 patients younger than 2 years of age treated with ETV.

## Materials and methods

Between December 1994 and December 2004, 21 patients younger than 2 years of age presenting with non-

communicating hydrocephalus were admitted to our department and underwent ETV. The study included 6 girls and 15 boys ranging in age from 9 days to 15 months, with an average age of 6.7 months. Sixteen patients were younger than 1 year of age. ETV was considered when preoperative imaging studies revealed a non-communicating hydrocephalus. The etiology of the hydrocephalus was idiopathic aqueductal stenosis in eight patients (one patient with failed endoscopic aqueductoplasty), other congenital anomalies in four, posthemorrhagic in three, and tumor-related in three. Three patients had previously been treated with a shunt. Two presented with a shunt infection and one with a shunt failure. During the follow-up period, neurodiagnostic imaging (computed tomography, magnetic resonance imaging, ultrasound) as well as clinical data including head circumference or fontanel bulging were studied. ETV was considered to be successful when shunting could be avoided.

## Results

ETV was successful in nine patients (43%), with a mean follow-up period of 26.2 months (ranging from 3 to 55 months). The procedure was successful in four patients with idiopathic aqueductal stenosis, in two with other congenital anomalies, in one posthemorrhagic, and in two with a tumor-related hydrocephalus. In the patient who had previously been treated with endoscopic aqueductoplasty, a successful ETV could be performed. In 12 patients, the ETV was unsuccessful after a mean follow-up of 3.3 months (ranging between 13 days and 16 months). These patients required a shunt. Ten of them were less than 1 year old when ETV was performed. A failed procedure was more frequent in the group of patients younger than 6 months of age. In one initially successfully treated tumor-related hydrocephalus, a shunt had to be inserted because a meningitis occurred after tumor removal. In one patient, a subdural hygroma occurred 1 month after ETV. It was treated with a subdural–peritoneal shunt. There was no permanent morbidity or mortality after the procedure.

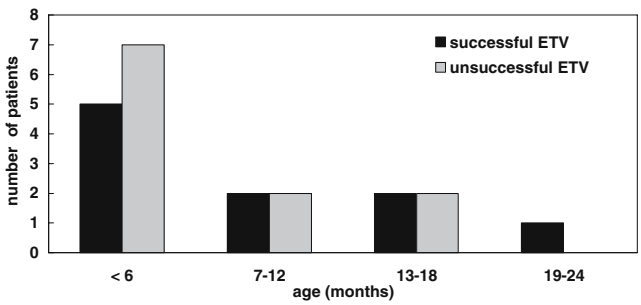


**Fig. 1** Age distribution at the time of ETV according to success of the procedure

**Table 1** Etiology of hydrocephalus vs success of ETV

| Etiology | Successful ETV | Unsuccessful ETV |
|---|---|---|
| Idiopathic aqueductal stenosis | 4 | 4 |
| Other congenital anomalies | 2 | 3 (1 previously shunted) |
| Tumor-related | 2 | 1 |
| Posthemorrhagic | 1 | 4 (2 previously shunted) |
| Total | 9 | 12 |

The distribution of age at the time of ETV according to the number of successful and unsuccessful treated patients is shown in Fig. 1. Table 1 indicates the different groups of etiology of the hydrocephalus concerning success and failure of ETV. The relationship between age and success of ETV seems to play a role in cases with idiopathic aqueductal stenosis. We found more unsatisfactory results for children within the first month of life (three of four patients). The entire relation for all patients (age, etiology of hydrocephalus, success/failure of ETV) is demonstrated in Table 2. A patient with a typical idiopathic aqueductal stenosis and hydrocephalus is presented in Fig. 2.

## Discussion

Although ETV has been established as a procedure to avoid shunt placement in patients with hydrocephalus of different etiologies, its use in children younger than 2 years of age still remains controversial. Our overall results show a success rate of 43%. Beems and Grotenhuis [12] reported a success rate of 53% in 66 ETV performed in children less than 2 years old. Finally, they divided the cohort of their patients into subgroups with respect to etiology of the hydrocephalus and found a variation of successful outcome from 27% in myelomeningocele to 87% in aqueductal stenosis. Therefore, they stated that the success of ETV mainly depends on the etiology of hydrocephalus, but not on the age of the patient. Their results are supported by some other authors who did not find any impact of age either [16, 18, 19]. In contrast, Kim et al. [17] found a poor surgical outcome in children younger than 1 year old, but were not aware of an influence of etiology. Reflecting our results, we agree with Koch and Wagner [13], Gorayeb et al. [14], and Fritsch et al. [20] that both features have to be considered as predictors of an acceptable outcome. The critical age in our study was younger than 6 months old because the highest failure rate was observed in this group of children. However, the role of etiology should not be underestimated. Several studies have shown promising results of ETV in infants with hydrocephalus due to idiopathic aqueductal stenosis. The success rate generally corresponds with an average of 50 to 70% for this kind of

**Table 2** Age at time of ETV versus etiology of hydrocephalus for all patients

| No. | Age (months) | Etiology | Success of ETV |
|---|---|---|---|
| 1 | 1 | Idiopathic aqueductal stenosis | No |
| *2* | *7* | *Idiopathic aqueductal stenosis; after failed aqueductoplasty* | *Yes* |
| 3 | 0.8 | Idiopathic aqueductal stenosis | No |
| 4 | 0.5 | Idiopathic aqueductal stenosis | No |
| 5 | 15 | Idiopathic aqueductal stenosis | No |
| *6* | *5* | *Idiopathic aqueductal stenosis* | *Yes* |
| *7* | *6* | *Idiopathic aqueductal stenosis* | *Yes* |
| *8* | *0.5* | *Idiopathic aqueductal stenosis* | *Yes* |
| *9* | *13* | *Other congenital anomaly* | *Yes* |
| *10* | *14* | *Other congenital anomaly* | *Yes* |
| 11 | 9 | Other congenital anomaly | No |
| 12 | 4 | Other congenital anomaly | No |
| 13 | 11 | Other congenital anomaly, previously shunted | No |
| *14* | *19* | *Tumor* | *Yes* |
| *15* | *3* | *Tumor* | *Yes* |
| 16 | 4 | Tumor | No |
| 17 | 1.5 | Posthemorrhagic | No |
| 18 | 4 | Posthemorrhagic | No |
| *19* | *2.5* | *Posthemorrhagic* | *Yes* |
| 20 | 4 | Posthemorrhagic, previously shunted | No |
| 21 | 15 | Posthemorrhagic, previously shunted | No |
| *Mean* | *7.8* | | *Yes* |
| Mean | 5.8 | | No |

Successful ETV is presented in italics.

hydrocephalus. Recently presented data by Fritsch et al. [20] of a large German multicenter study of 58 infants with pure aqueductal stenosis have shown a success rate of 50% after a minimum follow-up of 2 years.

Secondary aqueductal stenosis with associated hydrocephalus caused by hemorrhage, central nervous system infections, or malformations represent a group with a lower success rate after neuroendoscopic therapy in infants [11]. In our opinion, there exists predominantly a malresorptive and not an obstructive problem of cerebrospinal fluid (CSF) circulation, which is responsible for a higher failure rate after ETV. Reobstruction of the stoma as a result of newly developed arachnoid membranes might be one of the problems of failed ETV especially in posthemorrhagic or postmeningitic hydrocephalus [13, 21]. Another cause of hydrocephalus has not been mentioned yet in this paper. These are children with tumors of the posterior fossa including the brainstem and associated hydrocephalus. There is obviously an obstructive origin of the hydrocephalus, which leads to good results after ETV. Moreover,

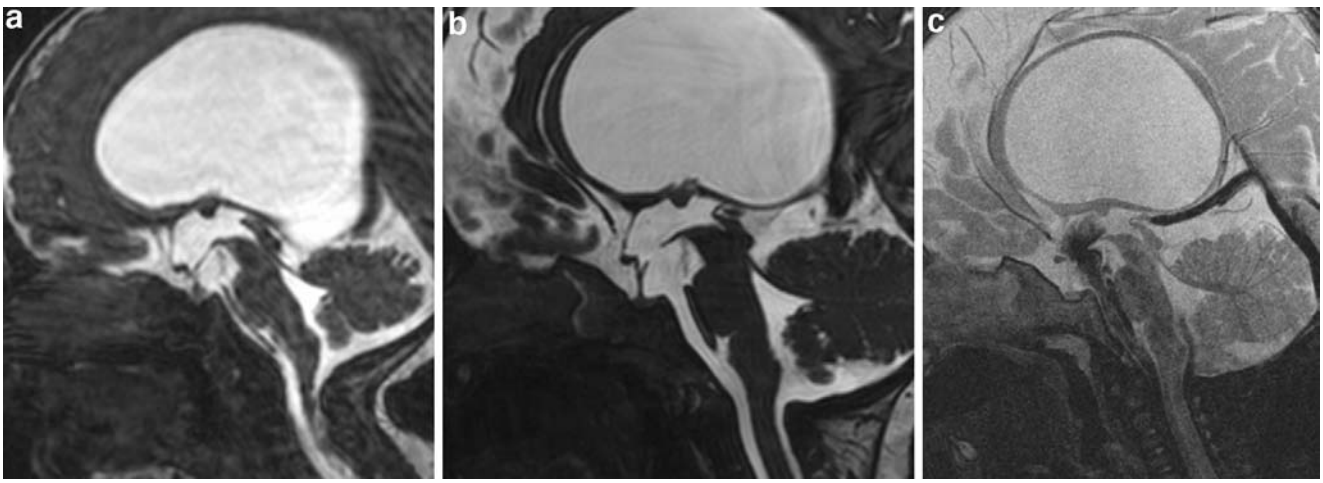


**Fig. 2** The 13-day-old girl was successfully treated with ETV. The preoperative (**a**) magnetic resonance (MR) image shows the triventricular hydrocephalus caused by an idiopathic aqueductal stenosis. The follow-up MR images after 6 months demonstrate a patent ventriculostoma and a decrease in size of the third and lateral ventricles (**b**) as well as the CSF flow void (**c**)

postoperative hydrocephalus after tumor removal is often a problem of obstruction of the fourth ventricle outflow or aqueduct. Both groups can be successfully treated by ETV [22–24].

## Conclusion

The success of ETV in children younger than 2 years of age suffering from non-communicating hydrocephalus seems to be dependent on both age and etiology. A failure of ETV occurred more often in infants younger than 6 months of age. Idiopathic aqueductal stenosis with associated hydrocephalus showed a good outcome in 50% of the patients. This success rate corresponds with other studies. Although the results of ETV in the treatment of hydrocephalus other than aqueductal stenosis do not show convincing results in our series, we recommend the procedure as the first choice of therapy in most of the children with non-communicating hydrocephalus regardless of age even in premature newborns. In premature newborns, each week without a shunt is a considerable benefit for these patients. The higher rate of complications and revisions after CSF shunting justifies this procedure as an initial step. However, clear evidence of how successful ETV will be in this group of children requires further prospective studies. A clinical and neuropsychological assessment has to be included in the long-term examinations. It is of great interest whether the persistent enlargement of the ventricles after ETV interferes with a good mental development of the patients compared with shunted patients in whom the ventricles are usually small or even collapsed.

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