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Repeat endoscopic third ventriculostomy: is it worth trying?

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Abstract *Object:* The goal of this study was to evaluate the safety, efficacy, and indications for repeat endoscopic third ventriculostomies (ETV). *Methods and results:* We reviewed the records of 20 patients who had undergone repeat ETV from 1987 to 1999. Their ages ranged from 8 months to 53 years (mean 17 years). The primary etiologies of hydrocephalus were: primary aqueductal stenosis (9 cases), tumor (5), Chiari malformation (2), prior infection (2), prior intraventricular hemorrhage (1), and blocked foramen of Monro (1 patient). The interval between the first and second ETVs ranged from 8 days to almost 6 years (mean 12.8 months). The intraoperative findings at repeat surgery were: occlusion of the primary orifice by scar (10 cases), virginal floor of the third ventricle (5 cases), pinhole ventriculostomy (3 cases), incompletely penetrated membrane (1 case), and blood clot occluding the orifice (1 case). The follow-up period ranged from 3 to 47 months (median 20 months). Repeat ETV was successful in 13 patients (65%). These patients did not require further shunting or other procedures during follow-up. Seven patients (35%) required placement of a shunt after repeat ETV. Several complications were observed in 1 patient (5%), including seizures, elevated ICP, bilateral pulmonary edema, and cardiac arrhythmia. This patient ultimately recovered fully; the ETV was successful, and the patient did not require a shunt. *Conclusions:* Based on the experience of this group of patients, repeat ETV is as effective and as safe as a primary ETV procedure, and should be attempted in selected patients.

Keywords Hydrocephalus · Endoscopy · Third ventriculostomy · Aqueductal stenosis

Introduction

Over the past 10 years, endoscopic third ventriculostomies (ETV) have become very popular. ETV is relatively simple, establishes a "natural" pathway for CSF flow, and helps avoid placement of and reliance upon hardware. ETV is generally considered a safe and effective treatment for patients with triventricular hydrocephalus, with a success rate of up to 70–90% [3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 22, 24].

While primary ETV has proved to be safe and effective, repeat ETV procedures have not been thoroughly studied and analyzed. Some authors have described their experience with repeat ETV [4, 7]. However, if the primary third ventriculostomy fails, most surgeons tend to insert a ventriculo-peritoneal shunt (VPS) rather than attempt an additional endoscopic procedure. Wishing to summarize a large body of experience with repeat ETV and to investigate whether this procedure is safe and worth trying again after an initial ETV, we performed a retrospective analysis of 20 patients operated on in four medical centers.

Clinical material and methods

We reviewed a series of 20 patients who had undergone repeat ETV procedures from 1987 to 1999. Information was obtained from patient medical records. These cases were taken from a larger series of ETVs, 541 patients in total, made up of 230 patients from Necker-Enfant Malades (Paris), 168 treated at Beth Israel (New York), 93 treated at the Tel-Aviv Medical Center (Israel), and 50 reported from NYU Medical Center (New York). There were no other repeat ETVs that were not included in our series. The following data were included in the study: patient age at first and second ETV, interval between surgeries, etiology of hydrocephalus, presence or absence of VPS at first and second ETV, visualization of the interpeduncular fossa (IPF), intraoperative appearance of the floor of the third ventricle at repeat ETV, perioperative complications, whether an external ventricular or spinal drain was placed following repeat ETV, and clinical and radiological outcome of primary and repeat ETVs.

All third ventriculostomies were completed endoscopically. Surgery was considered a *technical* success if an endoscope could be passed into the interpeduncular cistern and the surgeon could clearly identify the basilar tip and perforating arteries. Surgery was considered a success if the symptoms of increased intracranial pressure (ICP) resolved and the patient did not require a shunt during follow-up. Surgery was considered a failure if shunt placement was necessary.

Clinical outcome was classified as "immediate relief" if a patient was both relieved of symptoms within the first few hours of surgery and maintained this clinical improvement afterwards. Patients with "gradual relief" needed time until absorption was efficient. In the "no change" group the patients' condition remained essentially unchanged. Another group consisted of patients who deteriorated after the procedure.

Radiological studies included assessment of the ventricular size by CT or MR, and assessment of the flow void phenomenon on MR images.

Results

Since 1987, a total of 20 patients (9 male, 11 female) have each undergone repeat ETV at one of the participating institutions. Patient age at first ETV ranged from 5 months to 51 years (mean 16 years). At repeat ETV the age ranged from 8 months to 53 years (mean 17 years). Etiologies of hydrocephalus were: primary aqueductal stenosis (9 cases), tumor (5), Chiari malformation (2), prior infection (2), prior intraventricular hemorrhage (1), and blocked foramen of Monro (1) (Table 1). Owing to the limited numbers of patients with each primary pathology, no attempt to analyze the relationships between the etiologies and the outcome of the repeat ETV was made. The follow-up period ranged from 3 to 47 months (median 20 months). The interval between the first and second surgeries ranged from 8 days to 5.9 years (mean 12.8 months).

Table 1 Etiology of hydrocephalus (*IVH* intraventricular hemorrhage)

Primary aqueductal stenosis	9
Tectal tumor	5
Chiari malformation	2
Prior infection	2
Prior IVH	1
Blocked foramen of Monro	1
Total	20

Table 2 Presence of shunt (*ETV* endoscopic third ventriculostomy)

At first ETV	6 (30%)
At second ETV	1 (5%)
After repeat ETV	7 (35%)

Results of original ETV

Of the 20 patients involved in this study, 14 (70%) benefited from the original ETV for more than 1 month (1.3–71 months, mean 17.2 months). Two of these 14 remained symptomatic for a short period immediately after the original surgery, but were successfully managed with external ventricular drainage. Six patients (30%) did not benefit from the first ventriculostomy: they remained clinically unstable; temporary CSF diversion (attempted in 4 patients) was ineffective; and a second endoscopic procedure was done less than 1 month after the first procedure (0.3–0.75 month, mean 0.6 month). It is noteworthy that the primary ETVs were successful from the technical point of view in all except for 1 patient, in whom an incompletely perforated arachnoid membrane was found at the repeat ETV.

The success rate for initial ETV in the whole group of 541 was 75% in Beth Israel Medical Center, 70% in Necker Enfants Malades, 74% in Tel Aviv Sourasky Medical Center, and 75% in NYU Medical Center.

Presence of a shunt

At the time of the first ETV, 6 patients (30%) had VP shunts and 14 patients (70%) had no such hardware. After the first ETV the shunts was removed from all 6 patients. In 1 case it was replaced 2 months later. This patient was the only one who had a VP shunt present at the time of the second ETV. Following completion of the repeat ETV, 13 patients (65%) remained without shunts throughout the follow-up period. In 7 cases (35%) a VP shunt had to be placed within 4–33 days after the repeat procedure (Table 2).

Therefore, the success rate of a repeat ETV in this series, as measured by the need for a shunt after a second endoscopic procedure, was 65%.

Intraoperative findings

At repeat ETV, 9 patients (45%) had a hole obliterated by scar tissue, and 5 patients (25%) had a virginal floor of the third ventricle. A small, "pin-hole" opening was found in

Table 3 Intraoperative findings

Occlusion by scar	10 (50%)
Virginal floor	5 (30%)
Pin-hole orifice	3 (15%)
Incompletely penetrated membrane	1 (5%)
Blood clot	1 (5%)
Total	20

3 cases (15%). Blood clots and an incompletely penetrated membrane were found in 1 case (5%) each (Table 3).

Complications of the first ETV

The first ETV was uneventful in 17 patients (85%). The following complications occurred in 3 patients.

A 38-year-old woman developed a number of serious complications. Following surgery, she suffered a brisk but self-limiting bleed from a small perforating artery. Secondary to the arterial injury the patient developed a localized pontine infarct. In addition to the infarct, an acute thrombosis of some of the parasagittal veins and the vein of Labbe evolved on one side. The first ETV was functional for 22 days only. At that point her ventricles expanded and a repeat ETV was attempted. The stoma was found to be occluded by scar tissue. Even though the repeat ETV went smoothly, she required VPS placement 4 days after the second procedure.

A 1-year-old boy suffered an infection and CSF leak following the first ETV. He was treated with antibiotics, and an external ventricular drain (EVD) was kept open. After 10 days a repeat ETV was attempted. The procedure was technically uneventful, but the patient required a VPS placement 1 week after the second procedure.

A 13-year-old girl had an EVD in place for 6 days following the first ETV. The patient appeared to be EVD-dependent. After the drain was closed on day 3 after surgery, the patient developed Parinaud syndrome, which prompted us to open it again and keep it patent for another 3 days. Ten days after surgery she became symptomatic, and a repeat ETV was performed 4 days later. An incompletely penetrated arachnoid membrane and a small blood clot occluding the orifice were found. The second procedure was successful, and the girl remained shunt-free.

Complications of the repeat ETV

There was no mortality in this series. Nineteen patients out of the 20 (95%) had no complications at the repeat procedure. The surgeons did not observe any additional intraoperative difficulties and felt that the repeat procedures were technically similar to the primary surgeries.

In 1 patient, a 4.5 year old boy, the following series of complications developed. After a technically successful procedure and extubation on the operating table, the patient suffered generalized convulsions and respiratory arrest, requiring reintubation. The boy then developed pulmonary edema and cardiac arrhythmia. On day 5 after surgery a CSF leak from the wound appeared. This was managed with continuous lumbar drainage for 48 h. After removal of the drain the leakage resumed. A new drain was inserted for 4 more days. The leak stopped, and the patient returned to normal life. Despite the initial complications, the second procedure was ultimately successful, and the boy remained shunt-free.

Clinical outcome of repeat ETV

Seven patients (35%) experienced immediate relief of symptoms and did not require a shunt. The other 13 patients remained symptomatic, as after the initial ETV. Of these 13 patients, 6 were immediately shunted after the repeat procedure. The other 7 patients were treated by temporary CSF diversion. They were managed with EVD only (n=3), continuous lumbar drain only (n=1), or both (n=3). Six of them remained shunt-free.

Radiological outcome of repeat ETV

When comparing the MR images of the 13 successfully treated patients with the films of the 7 failed patients, we noted the following: 6 patients in the success group exhibited both a decrease in ventricular size and flow void phenomenon on mid-sagittal MR cuts, as opposed to only 1 patient in the failure group. One patient in each group displayed a decrease in ventricular size only. Five patients in the success group exhibited flow void phenomenon only on mid-sagittal MR cuts, as opposed to only 1 patient in the failure group. Only 1 patient in the success group exhibited no radiological changes. Three patients in the failure group exhibited no radiological changes.

Comparison of the successful repeat patients vs failures

The *interval* between the first and second ETVs did not affect the success rate of the repeat procedure (10.4±11.3 months in the success group, vs 15.5±26.7 in the failure group).

However, the *success of the first ETV* does seem to be significant: 76.9% of patients in the success group (10 out of 13) benefited from the first ETV for more than 1 month, while only 57.1% of patients in the failure group (4 out of 7) benefited from the first ETV for more than a month.

While the actual success of the first ETV seems significant, the *duration* of that success does not seem to be a factor. The 2 patients who benefited from the first ETV for the longest periods of time [a 17-year-old (at ETV1)

girl whose ventriculostomy remained operational for almost 7 years and a 6 month old boy who remained asymptomatic for 30 months after the first ETV] both unexpectedly failed at the second.

The average age of successful patients at the repeat ETV was 18.4±14.5 years, while the mean age of the failures was 16±18.2. This difference did not reach statistical significance.

Discussion

ETV is considered a safe and effective treatment for patients with triventricular hydrocephalus, with a success rate of up to 70–90%. [3, 12, 15, 16, 17] in the literature and 70–75% in the series of 541 patients from which our present repeat ETV cases were retrieved. For properly selected patients, this procedure is superior to VP shunting [2, 6].

Despite being an attractive procedure, at least 20% of patients who undergo ETV will fail in the first year following surgery. The failed patients fall into one of two categories. In the first, failure is recognized in the immediate postoperative period. The primary procedure does not lead to any significant period of clinical and / or radiological improvement. For this group, failure may be attributed to a technical problem during surgery, obliteration of the orifice during the immediate postoperative period, or malabsorption of the fluid [5]. In the second category are patients who benefited from a primary ETV for varying periods of time, with their hydrocephalus recurring only after an initial period of success.

We should point out that all primary ETVs were done successfully from the technical point of view, except in 1 patient, in whom an incompletely perforated arachnoid membrane was found at the repeat ETV. This means that presence of the "virginal floor" of the third ventricle or "pinhole" opening does not indicate a technical failure of the first procedure. It is rather a "natural" healing process that can happen in some patients. We feel it is an important finding, perhaps not referred to elsewhere in the literature. It should be noted that most patients enjoyed the results of their initial procedure clinically. The ventriculostomy was, therefore, patent for a while.

If an initial ETV fails, the alternatives are insertion of a VP shunt and reperformance of the neuro-endoscopic procedure. When a decision of this kind has to be made, three crucial issues should be discussed. First, how *safe* is a repeat ETV? Second, how *effective* is a repeat ETV? Finally, *who* would be most likely to benefit from a repeat ETV?

Safety and efficacy

Our multi-center experience suggests that a repeat ETV is at least as safe as the first ETV. In this series the mortality rate was zero. Nineteen patients out of 20 (95%) had no complications. We did not observe any such complications as significant bleeding or infection, both of which occurred after the first ETV in 1 case each. Nor did we observe most of the other complications described in the literature [1, 14, 15, 18, 20, 21, 23].

The success rate of 65% proves that a repeat ETV is as effective as a primary ETV.

Patient selection

One should notice that the different institutions may use different selection criteria for a primary procedure and also a different attitude to the definition of a "failure" after an initial procedure. These are the inevitable shortcomings of a multi-institution, retrospective study.

Our original hypothesis before analyzing the data was that an ideal candidate for repeat ETV would be

1) An adult patient
2) With an obstructive hydrocephalus
3) Who has benefited from the first ETV for a significant period of time (i.e. at least a month).

Contrary to our expectations, our data failed to prove our original hypothesis about the importance of age and interval between surgeries. However, we believe that the significance of these factors should be reevaluated in further larger studies.

The selection of patients for a repeat ETV should be based on essentially the same criteria that are used to recommend a primary ETV. In addition, there are two groups of primary ETV-alumni that appear to be likely candidates for successful repeat ETVs.

1. Patients for whom the first ETV was a success, as they are more likely to have a patent absorption system with the potential to successfully absorb CSF.
2. Patients for whom the first ETV was a failure, if the surgeon feels either that the procedure was not technically successful, or that bleeding or debris may be blocking the orifice, are also excellent candidates for success with a repeat ETV. In all these cases a repeat ETV should be attempted, as the potential benefits of a successful ETV that avoids the problems associate with permanent shunting clearly outweigh the risks of repeated surgery.

Conclusions

1. In this study group, failure of an ETV in most cases is due to obstruction of the orifice.
2. Repeat ETV is as safe as the primary ETV.
3. Repeat ETV in selected patients is as effective as the primary ETV and may be preferable to placement of a shunt.

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