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Results of Endoscopic Septal Fenestration in the Treatment of Isolated Ventricular Hydrocephalus

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Key Words
Endoscopic septal fenestration · Septostomy · Hydrocephalus · Neuroendoscopy · Septum pellucidum fenestration

Abstract
A surgical series detailing the results and complications of neuroendoscopy for the treatment of isolated lateral ventricular hydrocephalus (ILVH) has yet to be presented. This retrospective case review of 32 patients examines our experience at the Primary Children's Medical Center with endoscopic fenestration of the septum pellucidum (septostomy) for ILVH. The patients who underwent endoscopic septostomy between the years of 1993 and 2001 were identified from our database. Forty-three septostomies were performed, with a mean follow-up of 30.9 months. Fifty-three percent of initial septostomies remained patent. Nine patients had a least one more septostomy performed after failure of their initial septostomy. All but one was successful. Including repeat septostomies, 81% of the patients had relief of their ILVH on the last follow-up. No septostomy failures occurred later than 6 months postoperatively. A history of multiple previous shunt procedures was highly predictive of initial septostomy failure, increasing this risk 4.5 times. Complications involved significant intraventricular hemorrhage, wound breakdown, shunt infection and sterile meningitis in four cases. We conclude that endoscopic septostomy is a reasonable treatment option for ILVH, avoiding additional shunts. Outcome is negatively affected by multiple prior shunt procedures. Favorable results can be achieved with repeat septostomies in patients who have failed prior septostomy. Lasting results are expected for septostomies that remain patent after 6 months.

Introduction

Endoscopic surgery has found many applications in adult and pediatric neurosurgery. It has been particularly useful as an adjunct in the treatment of hydrocephalus, in which the endoscope is used to fenestrate different membranes to create alternate cerebrospinal fluid (CSF) pathways (e.g. 3rd ventriculostomy), to remove obstructing lesions (e.g. colloid cyst removal) or to reestablish normal paths of CSF flow (fenestration of multiloculated ventricles, acqueductal stent placement) [1–5]. Another form of hydrocephalus in which the endoscope has been employed is isolated lateral ventricular hydrocephalus (ILVH). In that case, the septum pellucidum (SP) is fenestrated to form a communication between the lateral ventricles [6–9].

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ILVH is due to an obstruction of the foramen of Monro (FOM). The causes of the obstruction vary, as seen by the examples listed in table 1. An endoscope may be used to fenestrate the SP and restore CSF communication between the lateral ventricles and potentially avoid or eliminate the need for a CSF shunt.

Our institution, along with others, has reported favorable results with endoscopic septostomy [9–14]. Unfortunately, these reports suffer from small sample sizes and lack of detail describing their septostomy techniques. In response to the lack of available data, we report our experience with endoscopic septostomy at the Primary Children's Medical Center. We describe the indications for surgery, examine the procedure itself and determine the success rate of the procedure in the treatment of ILVH. Furthermore, we report our surgical complications and analyze predictive factors for success.

Patients and Methods

Patient Review

A consecutive series of patients who underwent endoscopic septal fenestration between 1993 and 2001 was identified. These cases were identified through Opcoder (Accreditation Council for Graduate Medical Education, Chicago, Ill., USA), a computerized surgical database. This program was used to search for procedures containing the following key words: 'septostomy', 'septal fenestration' or 'septum pellucidum fenestration'. The charts of the identified cases were reviewed and the following data were obtained: patient demographics, etiology of hydrocephalus, presenting symptoms, radiologic findings, septostomy method, septostomy outcome, indication for reoperation and complications. Complications occurring within 30 days of the septostomy were noted. The patient's course was followed until the failure of their septostomy or the last recorded follow-up. Telephone interviews were used to supplement chart data, when necessary.

Statistical Analysis

The Student's t test for unequal variance was used to detect mean differences in continuous variables affecting outcome. The χ^2 test was used to detect variance between nominal variables and outcome. Factors affecting initial septostomy outcome were identified by constructing a Cox proportional hazard model. Initial septostomy survival was analyzed using a Kaplan-Meier curve.

Indications for Surgery

The indication for septostomy was ILVH. Clinical and radiographic evidence were necessary to support the diagnosis. Presenting symptoms that supported the diagnosis of ILVH included headache, nausea and vomiting, decreased level of consciousness, macrocephaly and irritability. In addition, radiographic evidence included asymmetrical ventricular size plus one of the following: isolation of contrast to one ventricle following intraventricular administration; progressive unilateral ventricular enlargement on serial imaging, or a mass lesion obstructing the FOM.

Table 1. Etiology of ILVH and examples

1	Neoplasms: subependymal giant cell astrocytoma, hypothalamic glioma
2	Congenital lesions: choroid plexus cyst, atresia of FOM, choroid plexus hypertrophy
3	Ventricular inflammatory conditions: bacterial ventriculitis, intraventricular hemorrhage
4	Iatrogenic: unilateral shunt overdrainage

Repeat septostomy was considered in patients with failure of their initial septostomy or recurrence of ILVH after an initially successful septostomy. In some cases, the septostomy failure was determined by the persistence of ILVH in the immediate postoperative period. A repeat septostomy was considered during the same hospital stay if: (1) the ventricular anatomy necessary to perform a septostomy was identified during the initial procedure; (2) there was a change in the ventricular conditions enabling better visualization of the anatomy (clearance of debris or blood, interval enlargement of the frontal horn), or (3) the surgeon felt that a different instrumentation or approach would improve the outcome of the septostomy (e.g. use of image guidance, change in endoscope or burr hole site). A repeat septostomy was contraindicated if, during the initial septostomy, the surgeon observed that the ventricular anatomy was too distorted by pathology (e.g. scarring) to identify any familiar landmarks that would allow safe and successful completion of the procedure.

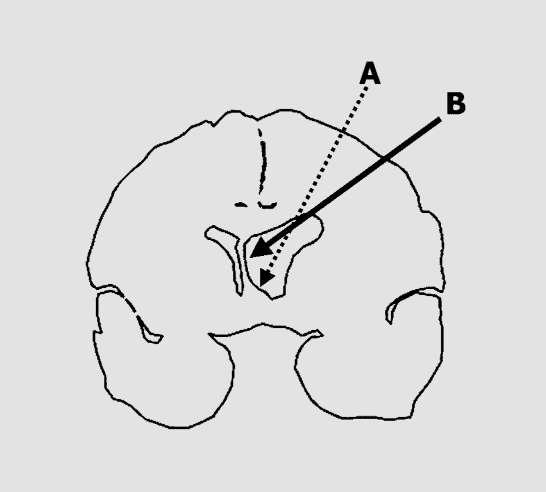
In a few cases, the patient's family refused a repeat septostomy or the surgeon, with the intent of simplifying an already complicated hospital stay, would elect to place a separate CSF shunt in the isolated ventricle. It is these patients, as well as those who had a previously functional septostomy, who would be candidates for a repeat septostomy if they return with a shunt malfunction or a septostomy failure, respectively.

Endoscopic Septostomy Technique and Postoperative Management

Several important factors related to the technique of endoscopic septostomy should be discussed. These include the choice of endoscope, surgical trajectories, septal fenestration and postoperative management. The senior author (M.L.W.) has had extensive experience in endoscopic septostomy, performing this procedure as early as 1977 and publishing it elsewhere [9, 15]. It is this technique which we will review briefly.

We almost exclusively use the rigid endoscope rather than the flexible or steerable endoscope for septostomies. In our early experiences, we found that an effective septostomy could be made through the straight trajectory provided by the simple rigid endoscope without having to employ the occasionally disorienting variable working angle seen in the flexible endoscopes. Because of the large diameter of the current rod-lens endoscopes, we prefer to use the thinner rigid fiberoptic endoscopes (Neuropen and High-Resolution Channel Neuroendoscope, Medtronic Inc., Minneapolis, Minn., USA). We find that the image clarity of these fiberoptic endoscopes is sufficient to effectively perform the septostomy.

In approaching the ventricle, we choose an entry point 2–3 cm more lateral than the standard coronal burr hole (Kocher's point) to



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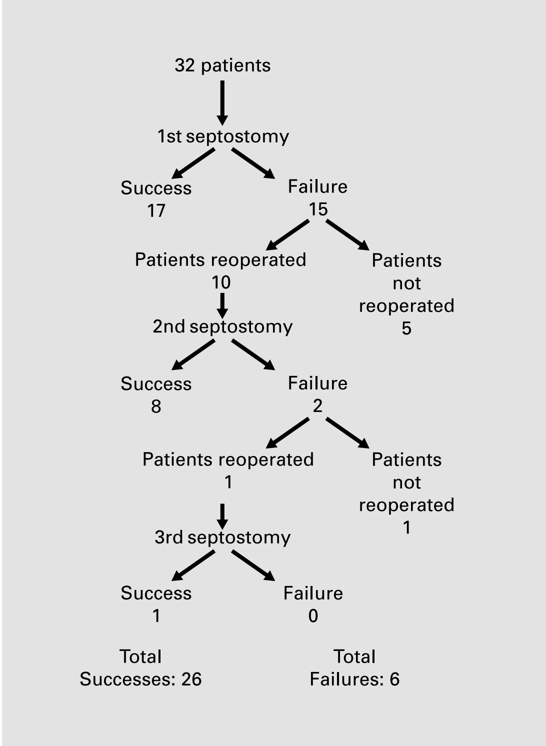

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Fig. 1. Angle of entry to ventricle in endoscopic septostomy. **A** (dotted arrow): Trajectory ideal for frontal ventricular shunt placements, third ventriculostomies. **B** (solid arrow): Trajectory for endoscopic septostomy with a more lateral entry point.

Fig. 2. Sequence of septostomies in 32 patients.

obtain a more perpendicular trajectory to the septum pellucidum (fig. 1). In some cases, if we think the angle of approach to the septum pellucidum is sufficient to give us good visualization of the relevant anatomy, we use preexisting burr holes. In cases in which the frontal horn is small or where the ventricular anatomy is complex, we employ image guidance, with either intraoperative ultrasound or frameless stereotaxy, to help guide the cannulation of the frontal horn and the fenestration of the SP.

After gaining access to the frontal horn, the identification of ventricular landmarks and the site of fenestration is critical. These landmarks include the choroid plexus, thalamostriate vein, septal vein and FOM. A number of detailed descriptions of the ventricular anatomy are available [8, 16, 17]. After the SP is clearly visualized, we choose a site approximately 1.0 cm superior and 2.0 cm anterior to the superior margin of the FOM. This corresponds to the 'avascular area' of the SP anterosuperior to the FOM that others have previously described [16]. We generally do not attempt a septostomy unless the anatomy is clear.

An area of 1.5–2.0 cm of the SP is then fenestrated with small punctures and the holes are connected and enlarged to a single fenestration. We have employed various instruments over the years to make and enlarge the holes, including the neodymium:yttrium-aluminum-garnet (Nd:YAG) laser, the laser fiber tip, blunt bipolar tip, Neuropen endoscope tip and the Fogarty balloon (3–4 Fr). After fenestration, we routinely attempt to visualize the contralateral ventricle by crossing the septostomy with the tip of the endoscope. Bleeding caused by the procedure clears when irrigated with warm lactated Ringer's solution for several minutes.

An external ventricular drain (EVD) is left in place for 2–4 days postoperatively to drain any debris or blood that the procedure may have produced. During this period, the EVD is progressively raised to a height of 15–20 cm above the FOM and ultimately clamped. It is removed if the patient shows no clinical signs of ILVH recurrence. The EVD is also useful in confirming the patency of the septostomy by providing access to the ventricle for the injection of radiopaque dye (1–2 cm^3 of Isovue-M 200, 41% iopamidol injection, Bracco Diagnostics Inc., Princeton, N.J., USA). A computerized tomographic (CT) scan is obtained approximately half an hour later to visualize the flow of the dye within the ventricular system.

In some cases of bilateral ventriculoperitoneal (VP) shunts, a septostomy is performed to reduce the number to a single shunt. In this setting, a VP shunt can be placed at the end of the procedure instead of an EVD if the CSF is relatively clear at the end of the operation.

Results

Between 1993 and 2001, 32 patients underwent 43 endoscopic septostomy procedures for ILVH at our institution. The mean age of the patients was 5 years (median 1.9 years, range 1 week to 18 years); 22 were male and 10 female. Mean follow-up after septostomy was 30.9 months (range 1 day to 8 years). The etiologies of hydrocephalus are listed in table 2. The most common etiology

Table 2. Etiology of hydrocephalus

Hydrocephalus etiology	Number
IVH	13 (40.6)
Neoplasm	6 (18.8)
Arachnoid cyst	3 (9.4)
Meningitis/ventriculitis	3 (9.4)
Chiari II	2 (6.2)
Porencephaly	2 (6.2)
Choroid plexus cyst	1 (3.1)
Congenital	1 (3.1)
Encephalocele	1 (3.1)
Total	32 (99.9)

Figures in parentheses represent percentages. The total percentage does not equal 100% due to rounding off. IVH = Intraventricular hemorrhage.

Table 3. Etiology of ILVH

ILVH etiology	Number
Posthemorrhage	8 (25)
Postinfection	7 (21.9)
Neoplasm	7 (21.9)
Intraventricular cyst	5 (15.6)
Postshunt	3 (9.4)
Congenital	2 (6.2)
Total	32 (100)

Figures in parentheses represent percentages.

Table 4. Details of septostomy

Parameter	Number
Image guidance	
Ultrasound	8 (18.6)
Stereotaxy	10 (23.3)
None	25 (58.1)
Endoscope type	
Rigid	28 (65.1)
Steerable	6 (14.0)
Unknown	9 (20.9)
Septostomy direction	
Large to small	29 (67.4)
Small to large	5 (11.6)
Equal size	6 (14.0)
Unknown	3 (7.0)
Fenestrator	
Laser energy	17 (39.5)
Endoscope	12 (27.9)
Laser fiber	7 (16.3)
Bipolar current	2 (4.7)
Unknown	1 (2.3)
N/A (aborted)	2 (4.7)
Dilator	
Endoscope	25 (58.1)
Laser energy	3 (7.0)
Laser fiber	2 (4.7)
Fogarty balloon	2 (4.7)
Unknown	9 (20.9)
N/A (aborted)	2 (4.7)
Ventricular drainage	
EVD	31 (72.1)
Internal shunt	12 (27.9)

Figures in parentheses represent percentages. N/A = Not applicable.

was intraventricular hemorrhage. Intraventricular hemorrhage was also the most common cause of ILVH; however, neoplasms and infections were almost as common (table 3). The number of prior shunt procedure for each patient ranged from 0 to 12, with a mean of 2.4 procedures.

Sequence of Treatment

Thirty-two patients underwent a septostomy; a total of 43 septostomies were performed (fig. 2). Ten out of the 15 patients in whom the initial procedure failed underwent a second septostomy, according to the indications previously mentioned. In 2 patients, the second septostomy failed, and 1 of these patients underwent a third septostomy.

Septostomy Details

The type of scope used was reported in 34 procedures. In 83.2% of the reported procedures, rigid endoscopes were used (table 4). Intraoperative image guidance, either stereotactic or ultrasonographic, was employed in 41.9% of the cases. In 67.4% of the cases, the large ventricle was entered and the fenestration was performed into the small ventricle. Nd:YAG laser energy and the endoscope were the two most common implements used to create the

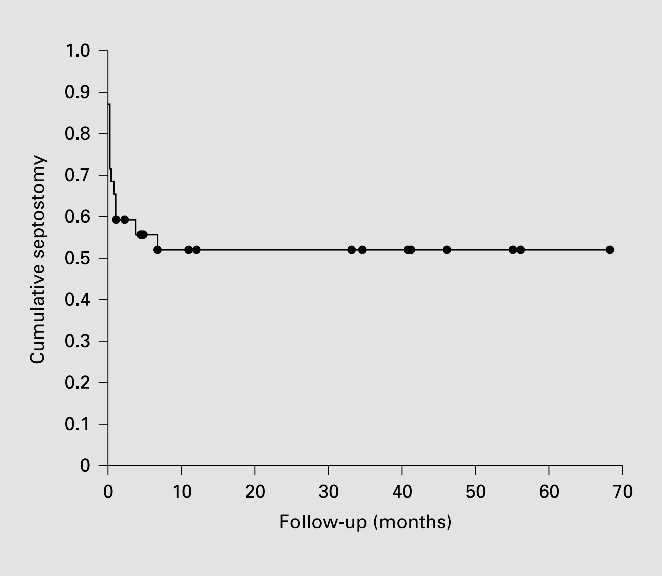

Fig. 3. Initial septostomy Kaplan-Meier survival curve. Events: failure or last follow-up. ● = Censored event.

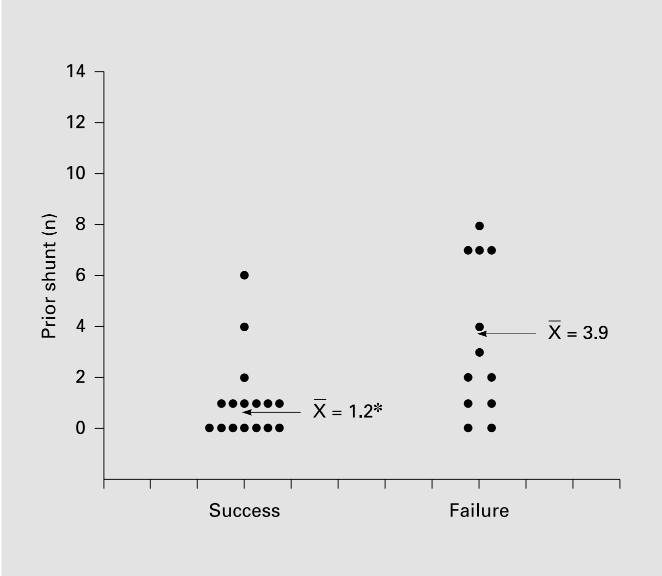

Fig. 4. Scatter plot of initial septostomy outcome and number of prior shunt procedures. $\overline{X}$ = Mean. * p = 0.01 (Student's t test).

Table 5. Septostomy patency rates

Group	Patency rate
All patients	26/32 (81.2)
All septostomies	26/43 (60.5)
Initial septostomies	17/32 (53.1)
Repeat septostomies	9/10 (90.0)

Figures in parentheses represent percentages.

fenestration. The endoscope was used most often (58.1%) to enlarge the hole in the SP. Ventricular drainage was used in all cases; external drainage was used more often than internalized shunts.

Septostomy Outcome

After the initial septostomy, 53% of the patients had patent septostomies (table 5). After repeat fenestrations on 10 of the 13 patients whose septostomies had failed, the proportion of patients with successful septostomies increased to 81%. Nine of the 10 patients who had repeat septostomies had patent septostomies on last follow-up (range 0.25–96 months, mean 32.3 months).

The Kaplan-Meier survival curve for initial septostomies is shown in figure 3. Note that no failures occurred later than 6 months after surgery, and the proportion of failure-free septostomies remained steady at 53%.

In 2 patients who both had a history of intraventricular hemorrhage and meningitis, the septostomy had to be aborted after insertion of the endoscope revealed ventricular anatomy unfavorable to septal fenestration. The first patient had severe ependymal scarring that prevented identification of any ventricular landmarks. The other patient had a contralateral VP shunt in place that had collapsed the ventricle. The SP could not be identified through the nonshunted ventricle and the procedure was aborted. This patient was subsequently admitted for a shunt malfunction. At the time of surgery, the SP was successfully fenestrated by approaching it using ultrasound guidance through the shunted ventricle, which was larger than it had been in the previous operation.

Complications

All patients were alive on last follow-up. Out of 43 septostomies, 4 complications were noted (9.3%). One patient had significant intraventricular hemorrhage after the septostomy was performed. This patient required external ventricular drainage for approximately 2 weeks, which was significantly longer than our routine of 2–4 days and which may have contributed to the early failure of the sep-

Table 6. Previous case series describing the results of endoscopic septostomy

Report	Year	Patients	Outcome	Follow-up, months range (mean)
Heilman and Cohen [6]	1991	2	neither patient required additional shunt	8 in one patient, other not mentioned
Walker et al. [9]	1994	9	7/9 satisfactory to good results	not mentioned
Gaab and Schroeder [14]	1998	4	all with smaller ventricles	6–15 (10.25)
Gangemi et al. [11]	1999	5	all symptom free at last follow-up	22–46 (34)
Oi et al. [12]	1999	5	all signs and symptoms improved at last follow-up	not specified
Hayashi et al. [13]	2000	4	2/4 required 2nd septostomy	2 and 3 months for 2nd septostomy cases, others not mentioned

tostomy. Another was admitted after presenting with irritability, lethargy, nausea and vomiting 1 week postseptostomy. A CT scan of the brain did not reveal hydrocephalus and CSF cultures were negative. A presumptive diagnosis of sterile meningitis was made and the patient improved after steroids were started. One patient had a shunt infection that occurred 26 days postseptostomy but 16 days after the shunt was implanted. The fourth patient had a dehiscence of the septostomy incision 1 month postoperatively. This appeared clean and was closed at the bedside. An infection did not develop.

Factors Affecting Outcome of Initial Septostomy

Several factors that may have affected the outcome of the initial septostomy were examined. A Cox proportional hazard model was constructed using age at septostomy, history of multiple previous shunt procedures (2 or more), premature birth and prior shunt infections using a forward conditional method. The only variable that significantly predicted initial septostomy survival was a history of multiple previous shunt procedures; patients with such a history were 4.5 times more likely to have their initial septostomy fail than those with one or fewer previous shunt procedures ($p = 0.012$). Figure 4 shows the difference between the two initial septostomy outcome groups (i.e. success/failure) according to the number of prior shunt procedures.

Analysis of the effect of the etiology of hydrocephalus on outcome was considered, but due to the small size of the subgroups if divided among etiologies, valid statistical analysis for this factor could not be provided. The effect of image guidance on septostomy outcome could also not be subjected to statistical analysis, since there was a selection bias in this series, where image guidance was used in the more difficult cases.

Discussion

To our knowledge, this is the largest and most detailed case series on the endoscopic treatment of ILVH. We have shown that endoscopic septal fenestration has an overall patency rate of 81%, with an initial patency rate of 53.1%. In most patients whose septostomies fail, repeat septostomies can provide lasting relief. No treatment failures occurred later than 6 months postoperatively. Multiple shunt revisions increase the risk for septostomy failure more than 4-fold. This procedure can be done safely, with 4 complications in 43 procedures in the present series.

Septostomy Outcome

Lewis et al. [4] reported one of the earliest and largest neuroendoscopy series for cyst fenestration in 34 cases of loculated hydrocephalus, 21 of which were for uniloculated hydrocephalus. 33% of the patients with uniloculated hydrocephalus avoided shunt placement. Their report, however, did not specify the different types of uniloculated hydrocephalus, of which ILVH is one specific type. Only two septostomy or 'transseptal fenestration' cases were identified that required repeat endoscopic procedures, and their outcome after the repeat procedures was not stated.

Table 6 lists the results of other published reports that included septostomy cases in which outcomes were clearly stated. The follow-up lengths are variable and not stated in some reports. When patient groups in these reports are pooled, 22 out of 29 (86.2%) appear to have had good outcomes, with some form of clinical or radiographic improvement in their ILVH. The outcome of our patients during their last follow-up is comparable with the outcome of these earlier reports, with 26 of our 32 patients (81%) free of ILVH. The initial septostomy success rate in our study of 53.1% may be lower than that in other series; however, it is difficult to make any meaningful comparisons based on these studies due to differences in the study population, septostomy technique and follow-up. Repeat endoscopic procedures for fenestrations that reseal have been reportedly effective in third ventriculostomies [18] and septostomies [4, 6, 13]. We found this to be the case in our series as well. Using the indications for repeat septostomies previously mentioned, we have had long-term success in approximately 90% of patients.

Septostomies were well tolerated by our patients, with no mortalities or major morbidities associated with the procedure. Out of the 43 procedures, 4 minor complications occurred within 30 days of the septostomy. One complication of a shunt infection may not have been directly due to the septostomy since the surgery that immediately preceded it was a shunt placement and the infection could have also been a result of this. Complications with our procedure are comparable to those reported in other studies published (table 6).

Septostomy Method

Our method of septostomy uses the rigid endoscope; others have had good results using flexible or steerable endoscopes. The flexible endoscope allows more variability in approaching the SP; thus, others have described septostomy approaches via the occipital horn or the frontal horn through a more medially placed burr hole than what we use [4, 7, 11]. Whether the choice of endoscope affects the outcome of septostomy was not analyzed in this study because of the small number of cases in which the steerable scope was used. We feel that the choice of scope probably does not affect septostomy outcome. It is more likely that the surgeon's mastery of ventricular endoscopic technique is more important than the choice of endoscope. For the novice neuroendoscopist, we recommend the rigid endoscope since the view through the endoscope camera can be quite disorienting, even in straightforward cases. With the rigid scope, the operator can orient more easily to its fixed perspective compared with the variable angles of vision from the flexible scope.

Other authors have advocated making the septostomy from the smaller to larger ventricle, asserting that the endoscopic anatomy of the enlarged ventricle is altered, making identification of the septostomy site difficult. Furthermore, entering the larger, presumably higher-pressure ventricle results in its decompression and loss of the pressure gradient required to keep the septostomy patent [11]. This has not been our experience. The majority of septostomies reported in our series (67.4%) were performed by making the hole in the SP from the larger to the smaller ventricle. This reflects our bias in approaching the SP from the ventricle that we can enter most easily. The larger ventricle provides the endoscopist more working room and greater ease in identifying the landmarks. We did not commonly observe distortion of the ventricular anatomy that precluded a safe septostomy; only 2 procedures were aborted because of anatomic difficulties. We do not believe that the initial loss of the pressure gradient between the ventricles during the procedure affects the long-term patency of the septostomy, since in a normal adult, enough CSF is produced in a day to replace the total CSF volume three times over, which should be more than enough to rapidly re-establish this pressure gradient [19].

A disadvantage to this approach is the potential for perforating the lateral wall of the contralateral ventricle, especially in the setting of a contralateral slit ventricle. A more posteriorly directed instrument through the SP can cause serious morbidity by damaging vital structures that come to the ventricular surface, such as the genu of the contralateral internal capsule or the thalamus [17]. By carefully controlling the depth of the instrument perforating the SP and by using the coronal approach described above, this complication can be avoided, as is evident in the current series. Others have described applying suction to the septum with a catheter and pulling it away from the contralateral ventricle to enlarge the space that the perforating instrument enters [20].

The type of instruments used to perforate and enlarge the hole in the SP is probably not crucial to the patency of the septostomy. In addition to the implements we used, others have used monopolar coagulation, potassium titanyl phosphate laser energy and the saline torch to effectively create and enlarge the septal fenestration [4, 6–8]. We believe, as do the authors of other reported series, that the larger the septostomy, the better.

Initial Septostomy and Long-Term Results

In our study, patients with 2 or more prior shunt procedures were 4.5 times more likely to have their initial septostomy fail. This may be one of the reasons why the patency rate for initial septostomies in this series was 53%, since a large proportion of our patients (40.6%) had 2 or more prior shunt procedures, with a mean number of 2.4 prior shunt procedures for all patients in this series. We suspect that the etiology of the ILVH may have some influence on the outcome of the initial septostomy but we were not able to show this because of the limited sample size.

Of the 43 septostomies performed, no failures were observed after a 6-month postoperative period. This novel observation may be because whatever reparative process is involved in the ventricle is completed sometime in that 6-month period. Thus, if the septostomy remains patent at the resolution of this reparative period, then further closure of the fenestration is less likely.

There are no studies documenting the survival of shunts placed for the treatment of ILVH. Thus, there were no suitable historical controls to compare outcomes in ILVH cases treated with a shunt or a septostomy. We attempted to compare the initial septostomy survival with the initial shunt survival in the randomized Shunt Design Trial by Kestle et al. [21]. A survival curve for initial ventriculoperitoneal shunts from this study is shown in figure 5 [21]. Note that the 2-year survival rates for the two procedures are both just better than 50%. The patient population of the randomized Shunt Design Trial was different from ours, since it dealt with initial shunt placement in previously unshunted patients who were mostly neonates (median age 82 days). In contrast, the majority of our patients was older (median age 1.9 years), had previous shunt procedures and had more complicated shunt histories. Despite the increased complexity of the shunt history of our patients, the initial patency rate of the septostomy was only slightly worse than that of the initial shunt at 1 year (53 vs. 62%, respectively) and comparable at 2 years postoperatively (53 vs. 52%, respectively), with none of the septostomies failing after the first 6 months postoperatively.

In addition to the comparable 2-year survival rates between the initial septostomy and the initial shunt, we have shown that repeat septostomy after initial failure improves septostomy survival to 81%. Thus, we believe that endoscopic septostomy may represent a reasonable alternative to the shunt in the treatment of initial and recurrent ILVH, especially in centers experienced in neuroendoscopy.

Limitations of the Current Study

The retrospective nature of this study imposes some limitations [22, 23]. The technique of septostomy was evolving during the study period, as was the instrumentation. The ability of the surgeons to perform the procedure was varied and evolving as well. Both of these factors contributed to variability in the septostomy method, which may have affected the ultimate outcome. At times the lack of documentation in the charts hampered data collection, which affected our ability, for example, to further examine the details of the septostomies (e.g. size of fenestration, type of endoscope used) that we thought might affect the septostomy patency. We were also unable to report

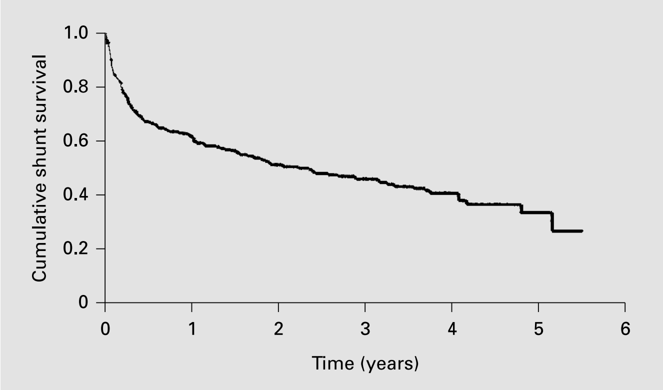

Fig. 5. Initial VP shunt Kaplan-Meier survival curve. Taken from the randomized Shunt Design Trial [21].

more details on the group of patients that underwent repeat septostomies since sometimes the specific indications for repeat septostomy versus CSF shunting were not clearly stated in the chart.

In addition, there was no good way to determine the total number of patients treated at our institution for ILVH during the same time period as the study. Although our results are favorable, the lack of matched controls, in this case, those patients with ILVH treated with multiple shunts, or even good historical controls limits the strength of the recommendations that we can make regarding the choice of endoscopic septostomy over traditional CSF shunting in the treatment of ILVH.

Despite the relatively large patient size of this study compared with previous studies, we still did not have enough patients to provide the statistical power necessary to further analyze factors that may affect clinical outcome, such as the etiology of hydrocephalus.

Conclusions

Endoscopic septostomy provided relief of ILVH in 81% of the cases. After initial septostomy failure, repeat septostomy can achieve good clinical results in selected patients. If septostomy patency is maintained after 6 months postoperatively, then failure is unlikely to occur. Multiple prior shunt procedures increase the risk of initial septostomy failure. Endoscopic septostomy appears to be a reasonable alternative to a shunt in the management of patients with ILVH.

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