The popularity of lumbar shunts has waxed and waned, thought to be a consequence of the use of polyethylene tubing (PE) — a technique that has been widely used in the pediatric population. Since the late 1960s, the use of PE shunts has diminished, and shunts made of silicone tubing have become the standard. However, since the early 1970s, there has been a resurgence of interest in PE shunts, and the use of PE shunts has increased. The popularity of PE shunts has been attributed to their ease of handling, their durability, and their low cost. However, PE shunts also have some disadvantages, including the risk of infection and the need for frequent replacement.

We have recently reported the incidence of ventriculitis in PE shunt patients (1). We have also conducted a retrospective review of patients who underwent PE shunt placement at our institution. Our findings suggest that PE shunts are associated with a higher incidence of ventriculitis than silicone shunts. This is consistent with previous reports, which have shown that PE shunts are associated with a higher incidence of infection than silicone shunts.

In conclusion, PE shunts are a viable option for the treatment of hydrocephalus in children. However, the use of PE shunts should be considered in the context of other factors, such as the patient's age, the presence of infection, and the availability of silicone shunts.
Children, Toronto, Ontario, Canada, in order to determine the actuarial survival of these shunts and the types of malfunctions seen with their use.

PATIENT POPULATION

One hundred and forty-three patients in whom an LP shunt was inserted at The Hospital for Sick Children between January 1, 1974, and September 1, 1991, were included in the study. There were 86 boys and 57 girls, and the mean age at the time of the first insertion was 3.3 years (range, 18 d to 17.8 yr) with 45% of the patients being younger than 1 year and 60% being younger than 2 years of age. The indication for shunting is shown in Table 1.

Hydrocephalus

Of the 116 patients treated by LP shunting for hydrocephalus, 39 (34%) had idiopathic hydrocephalus, 29 (25%) were posthemorrhagic, 29 (25%) were posttraumatic, 7 (6%) were postinfectious (5 secondary to bacterial meningitis and 2 after encephalitis), and 12 (10%) were grouped together as "other." Within the posthemorrhagic group were 23 premature births, 3 birth traumas, 2 neonatal chronic subdural hematomas, and 1 teenage subarachnoid hemorrhage. The 12 patients forming the group termed "other" consisted of 4 cases of hydrocephalus associated with Crouzon’s disease and 1 case each associated with the following: Reye’s syndrome, polypropenencephaly, gargoylism, Hunter’s syndrome, osteopetrosis, leukemia, arachnoid cyst, and sagittal sinus thrombosis. Radiological confirmation of communication between the subarachnoid space and the ventricles was obtained by isotope or ventricular studies before shunt insertion in 84% of the patients.

Cerebrospinal fluid fistulae

Under the heading of CSF fistulae, we have included true fistulae and pseudomeningoceles. In total, there were 17 patients in whom an LP shunt was inserted for control of a CSF leak—8 after posterior fossa tumor surgery, 5 after supratentorial craniotomy, 3 after trauma, and 1 spinal meningocele.

TABLE 1. Indications and Type of Lumboperitoneal Shunt Inserted

<table>
<thead>
<tr>
<th>Indication for Shunt Insertion</th>
<th>No. of Patients</th>
<th>T-tube Shunt</th>
<th>Percutaneous Shunt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocephalus</td>
<td>116 (81.1%)</td>
<td>93 (80%)</td>
<td>23 (20%)</td>
</tr>
<tr>
<td>Cerebrospinal fluid fistula</td>
<td>17 (11.9%)</td>
<td>8 (47%)</td>
<td>9 (53%)</td>
</tr>
<tr>
<td>Pseudotumour cerebri</td>
<td>10 (7.0%)</td>
<td>0</td>
<td>10 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>101</td>
<td>42</td>
</tr>
</tbody>
</table>
limb neurological changes, or neurogenic bladder were excluded (eight posterior fossa tumors, five patients with cerebral palsy, and one patient with spina bifida). Likewise, neck pain in patients with posterior fossa pathology was not recorded. Because the objective is somewhat different when an LP shunt is used for control of CSF fistulae or pseudotumor cerebri as compared with overt hydrocephalus, a special note was also made of whether the treatment was successful in controlling the condition and whether the patient appeared to become shunt dependent.

RESULTS

General complications

The mean follow-up time (time to last follow-up, time to removal of LP shunt, or death) was 5.7 years (range, 5 d to 17.5 yr), and during this period, there were five deaths, of which one was shunt related (see Unique Complications below). Figure 1 is a Kaplan-Meier shunt malfunction-free survival curve and shows the survival characteristics for each group of shunted patients. As can be seen, there is approximately a 50% chance for an LP shunt inserted for hydrocephalus surviving for 5 years. There is a dramatic early malfunction rate seen with the use of this type of shunt in patients with CSF fistula and pseudotumor cerebri, although the difference between these groups and the hydrocephalic group does not reach statistical significance. Figure 2 is a similar curve, but this one displays survival by shunt type. The T-tube shunts have a significantly better survival rate ($P < 0.003$) than do those inserted percutaneously.

Table 2 gives a breakdown of the type of first shunt malfunction, and from this, it can be seen that the percutaneous-type shunts have a higher incidence of shunt migration (19 versus 9%). In fact, the T-tube shunts experienced no true migration, but over time and associated with the growth of the patient, the proximal part of the tube was drawn out of the

![FIGURE 1. A Kaplan-Meier shunt malfunction-free survival curve is presented and shows the survival characteristics for each group of shunted patients. Approximately 50% of LP shunts inserted for hydrocephalus remain free from surgical intervention for at least 5 years.](image)

![FIGURE 2. The Kaplan-Meier malfunction-free survival curves for the T-tube and percutaneous-type LP shunts. The probability of malfunction and time to malfunction are statistically different ($P < 0.003$) for the two types of shunts.](image)

<table>
<thead>
<tr>
<th>Type of Malfunction</th>
<th>T-tube Shunt ($n = 101$)</th>
<th>Percutaneous-type Shunt ($n = 42$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstruction</td>
<td>33 (32%)</td>
<td>13 (32%)</td>
</tr>
<tr>
<td>Overdrainage</td>
<td>10 (10%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Migration/fracture</td>
<td>9 (9%)</td>
<td>8 (19%)</td>
</tr>
<tr>
<td>Underdrainage</td>
<td>9 (9%)</td>
<td>5 (12%)</td>
</tr>
<tr>
<td>Infection</td>
<td>3 (3%)</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>Arachnoiditis</td>
<td>3 (3%)</td>
<td>0</td>
</tr>
<tr>
<td>No malfunction</td>
<td>35 (35%)</td>
<td>9 (21%)</td>
</tr>
<tr>
<td>Converted to ventriculoperitoneal shunt</td>
<td>14 (14%)</td>
<td>7 (17%)</td>
</tr>
</tbody>
</table>

In four patients, the T-tube had become calcified proximally and fractured. The mean time to the occurrence of this type of mechanical accident was also quite different between the T-tube shunts (6.62 yr) and the percutaneous type (40 d).

Closer analysis of the data also showed that the percutaneous-type shunts failed poorly in infants younger than 6 months of age, with a mean time to first shunt malfunction for this group (eight patients) of only 0.59 years compared with 3.02 years for the T-tubes. Approximately half of all of the first shunt malfunctions were due to obstruction, and these were usually distal (63%) and required a relatively minor surgical procedure for revision. In total, there were 239 LP shunt malfunctions during the study period, giving an average of 1.7 malfunctions per study patient (or an average of 2.4 malfunctions per patient among those who required subsequent surgical intervention). The types of shunt malfunction seen over the whole study period were similar to those seen at the time of first shunt malfunction. By the end of the study, a total of 40 patients had been converted to a ventricular shunt. There were three chronic subdurals that required treatment, one acute subdural, and one acute extradural. The latter two patients sought treatment after significant head trauma.

*Neurosurgery, Vol. 32, No. 3, March 1993*
Cerebrospinal fluid fistulae

Although the LP shunts were successful in reducing the size of all of the posterior fossa pseudomeningoceles, three of the eight patients required insertion of a ventricular shunt within 1 month for control of hydrocephalus. In fact, by 1 year, five of the eight patients were using ventriculoperitoneal (VP) shunts, and of the remaining three patients, one had an x-ray taken some 3 years after shunt insertion showing migration out of the spine and two are shunt dependent and have required a total of 11 revisions between them (over a mean follow-up of 9.6 yr).

Of the remaining nine patients treated for CSF fistulae, LP shunting was successful in eight cases but six patients required surgical reintervention to deal with shunt problems—four of these being necessary within 2 months of the initial shunt insertion. Two patients had recurrence of the CSF leak associated with shunt malfunction, and three patients had symptoms of raised ICP at the time of shunt malfunction and would appear to be shunt dependent. Three patients required the inclusion of horizontal/vertical devices (Cordis Corp., Miami, FL) for overdrainage, and by the end of the study, four patients had the shunt removed (one because of infection, one because of poor peritoneal absorption, and two because of overdrainage) of these, two were converted to VP shunts.

Pseudotumor cerebri

After LP shunting, all but one of the patients with pseudotumor cerebri showed marked improvement with relief of headache and resolution of papilledema. However, despite a short follow-up period (mean, 2.9 yr; range, 0.2–8.9 yr), 7 of 10 patients have required a total of 16 revisions with a mean time to the next operation of 1.5 years (20 d to 7.3 yr). In particular, there have been six cases of migration (in five patients), five cases of obstruction (in three patients), one shunt tubing fracture, and four patients have required insertion of a horizontal/vertical device to control symptoms of overdrainage. Also of interest is the fact that all seven patients had symptoms of raised ICP when their shunts malfunctioned. In three of these patients, the malfunction was less than 3 months after shunt insertion and may reflect recurrence of pseudotumor cerebri, but in the other four patients, the malfunction was between 1 and 7.9 years after shunt insertion and possibly indicates shunt dependence. Of the three patients in whom revisions have not been undertaken, two have only been monitored for a mean of 3 months and both are complaining of low-pressure headache. The third patient was admitted some 3 years after shunt insertion with headache and blurred vision but with no change in visual acuity on formal testing, and her symptoms settled without treatment.

Unique complications

We have previously reported on the development of tonsillar herniation using this study group (10). In summary, we found a rate of tonsillar herniation of 70% among asymptomatic patients, whereas fewer than 5% of the study population required surgical intervention for this complication. In total, 12 of 135 patients (8.8%) complained of neck pain and this was often in association with a shunt malfunction. In addition, the only shunt-related death in the series was from unsuspected tonsillar herniation 2.5 years after shunt insertion. Another patient, who had a congenital heart defect, died 2 months after LP shunt insertion and at postmortem was also found to have tonsillar herniation.

Table 3 gives a breakdown of the unique complications after the exclusions noted previously. Fourteen percent of the patients had evidence of scoliosis, and the mean time to documentation of this was 5.7 years. The scoliosis was usually mild, although in one patient the curvature reached 104 degrees and required orthopedic surgical intervention. This patient was converted to a VP shunt 5 years before the orthopedic instrumentation because of the development of a foot-drop. Although this improved after the removal of the LP shunt, her spinal curvature continued to progress. A computed tomographic myelogram performed before the orthopedic procedure showed no evidence of arachnoiditis or tonsillar herniation.

Limited spinal flexion often resulted in an inability of the patients to reach below the knees and was noted in 13.7% of patients; lumbar hyperlordosis was noted in two patients. Back pain (10%) with or without sciatica (10%) frequently occurred at the time of a shunt malfunction and was usually self-limiting. There was evidence of nerve root involvement in eight cases consisting of three patients with foot-drop, one patient with foot numbness, one patient with equinovarus, one patient with mild calf-muscle wasting, and two patients with lower limb reflex changes. Arachnoiditis was confirmed by radiological studies or at the time of surgery in nine patients. Although five patients had urological symptoms, urodynamic testing was abnormal in only one patient. In total, 11 patients required conversion to ventricular shunts as a result of these unique complications.

DISCUSSION

LP shunts have certain obvious advantages when compared with other forms of CSF diversion but unfortunately also have some unique complications. Because this form of shunting has been advocated by some as the treatment of choice for communicating hydrocephalus (3, 6, 37, 42), we undertook this study in order to ascertain the rate of complications associated with LP shunting in the pediatric population. Other areas in which LP shunting has gained favor include the treatment of pseudotumor cerebri (22–24, 29), the management of postoperative pseudomeningocele (5, 22, 29, 37, 42), and CSF rhin-
orhea (6, 7, 14, 29, 37, 42, 43). Virtually all of the literature cited above has included some pediatric cases, although usually only in infants older than 2 to 3 years of age. The use of the silastic T-tube developed by Hoffman et al. (17) or the microsurgical technique described by Aoki (3) have made it feasible to perform LP shunts even in the newborn and the premature infant.

Communicating hydrocephalus

Although there are no large series reported with the use of LP shunts in the pediatric population, it is apparent from the literature that percutaneous-type LP shunts do not fare as well in this group of patients as they do in the adult population (3, 6, 22, 29). Eisenberg et al. (11) reported revisions in 17 of 34 pediatric patients (50%) with 13 (38%) requiring removal of the silastic percutaneous-type shunts. Kuwana and Kuwabara (29) had a malfunction rate for their percutaneous-type shunt of 64.7% (11 of 17), whereas James and Tibbs (22) reported successful shunting in only one of four patients under the age of 4 months—again using a percutaneous-type type. Aoki (6) reported on 28 pediatric patients out of a series of 207 LP shunt patients (5 premature infants having the shunt inserted via a laminectomy while the rest were inserted via a Touhy needle) with 21% requiring at least one revision. In contrast, only 14% of the adult patients in this last series required revision and, likewise, revisions were only necessary in 14% of the 130 largely adult patients reported by Selman et al. (37).

This difference in shunt survival with use in the adult and pediatric populations may reflect a combination of factors. In particular, the indications for shunting are quite different with the adult series consisting of a large number of patients with "normal pressure hydrocephalus," whereas the pediatric group tend to have "active" hydrocephalus as revealed by the presence of spayed sutures, enlarging head circumference, and the clinical manifestations of raised ICP. Other factors that may explain the discrepancy in function include greater mechanical stress (including growth) in the pediatric population, the length of follow-up (mean of only 36 mo in the group reported by Selman et al. [37]), and the relative size of the shunt tubing in the thecal sac.

In our series, the mean follow-up was 5.7 years and there was 1 shunt-related death during the follow-up period secondary to tonsillar herniation (9). Sixty-nine percent of the patients treated for hydrocephalus required a revision, and by the end of the study, 32% of the patients had been converted to a ventricular shunt. Patients in whom T-tube shunts were placed fared better than did those who received percutaneous shunts, and by the end of the study, 66% of the T-tubes had malfunctioned as opposed to 79% of the percutaneous shunts and the mean time to first shunt complication was 3.61 years as compared with 1.15 years. This study confirms the poor function of percutaneous-type shunts in patients younger than 6 months of age (mean time to first accident of 0.59 yr), and when analyzed with this group excluded, the mean time to first shunt complication improves to a more respectable 2.67 years for the percutaneous-type shunt.

A previous review of all forms of CSF diversion from this institute (18) showed LP shunts (a combination of both T-tube and percutaneous shunts) to have a 6-month failure rate of 22.9%, which was superior to that for VP shunts (34.2%). The 6-month figure for this study is similar, with a failure rate of 22.6%. As emphasized by Sainte-Rose et al. (36), shunt failure is a time-related event and therefore is best considered by actuarial survival; unfortunately, however, there are few reports in the literature with which to compare 5-year shunt survival. Although comparison with patients undergoing ventricular shunting is not strictly valid because of the differing etiologies of the hydrocephalus, it appears that the T-tube survival seen in this study is similar to that seen with VP shunts in a large pediatric series (36)—despite the initially lower malfunction rate noted at 6 months (18). In contrast, Aoki (6) found a revision rate for LP shunts to be approximately half of that for VP shunts in both pediatric and adult patients.

Type of shunt malfunctions

As is seen with VP shunts (36), the most common type of malfunction with LP shunts is obstruction, which accounted for 48.2% of all first shunt complications. However, whereas only 24% of VP shunt obstructions are due to blockage of the peritoneal catheter (36), the figure for the LP shunts in this study was 63%. Infection remains a significant problem with all forms of CSF diversion (2, 30, 39) and is a factor in the majority of ventricular shunt-related deaths (30, 39). Although LP shunts have been previously reported to have low infection rates of the order of 1% (6, 16, 17, 22, 39, 42) (possibly because of the small area that is exposed at the time of surgery (16)), the overall infection rate for this study was similar to that seen for VP shunts (3.3% for T-tubes but 12.5% for percutaneous type). It is of some interest that only two of the six infections at the time of first shunt complication were early (less than 2 mo from shunt insertion), whereas the mean time to infection for the remaining four patients was 1.36 years; 2 of these were associated with intercurrent medical problems: one appendicitis and one pneumococcal meningitis. Recurrent infections, which are frequently problematic with infected VP shunts, were not seen in this series. The treatment for shunt infection was relatively simple and consisted of removal of the shunt, antibiotics, and replacement either with another LP shunt or with a ventricular shunt.

At the time of first malfunction insufficient drainage had occurred in 10% of the study population, and of these, eight patients were converted to ventricular shunts. Overdrainage manifested itself clinically as low-pressure headaches or chronic subdural hematomas and required surgical reintervention in 8% of the study patients at a mean time of 0.6 years. By the end of the study, chronic subdural hematomas and overdrainage requiring another operation had occurred in 11% of patients. Sainte-Rose et al. (36) found overdrainage as a cause of malfunction in 7% of a large series of patients with VP shunts, and another 5.3% suffered from isolated ventricles—another possible consequence of overdrainage (36). Aoki and Mizutani (4, 6) have warned of the development of acute subdural hematomas after mild trauma in patients with LP shunts; however, this was not a problem in this series.
It appears that, in the pediatric population with growth of the patient, there is an increased tendency for migration to take place, and if migration is physically impossible, then the shunt may fracture (36). These long-term problems affected 7.7% of the T-tube shunts at a mean time of 6.62 years—more than twice as long as the same problems reported for VP shunts (36)—and may reflect the different growth vector (horizontal rather than vertical). "Acute migration" was a significant problem with the percutaneous-type shunts and was the indication for first revision in 19% of the patients with a mean time to malfunction of only 40 days. This complication has occurred despite the use of the provided silastic sleeves (which more recently have been reinforced with silastic glue).

Diverse indications for lumboperitoneal shunting

The diverse use of LP shunts has been previously reported but again largely in relation to the adult population (6, 22, 37). As with the results from previous studies, LP shunts were highly successful in dealing with the primary indication (CSF fistula, 15 of 16; pseudotumor cerebri, 7 of 8) in this series. However, it is apparent from the results that there was a high rate of malfunction of the LP shunts in this group of patients, and a significant percentage required conversion to a VP shunt, had problems with overdrainage, or became shunt dependent.

Cerebrospinal fluid fistulae

The reported incidence of hydrocephalus requiring ventricular shunting in children after posterior fossa tumor resection is 30 to 40% (46). Conversely, the presence of a ventricular shunt before posterior fossa tumor resection (a policy not advocated by this department) has been shown to reduce significantly the occurrence of postoperative pseudomeningocele formation and CSF leakage (32), indicating that hydrocephalus plays an important role in the development of this problem. In this study, seven of the eight patients treated with LP shunts for posterior fossa pseudomeningoceles are reliant on chronic CSF diversion for the treatment of concomitant hydrocephalus (five VP and two LP). In three of these patients, conversion to a ventricular shunt was undertaken within 1 month. Although the number of patients with posterior fossa pseudomeningoceles treated with LP shunts in this study is small, the results to date are poor and we do not advocate this form of treatment for this problem.

Surgical repair remains the mainstay of treatment for supratentorial CSF fistulae, but LP shunting has been successfully used to control this problem in cases where the leak is not radiologically apparent or where additional open surgical approaches have failed (6, 7, 14, 22, 37, 43). As seen with the treatment of posterior fossa pseudomeningoceles, some patients in this group have hydrocephalus as the underlying cause for the fistula and LP shunting may not be indicated unless there is adequate communication with the spinal subarachnoid space.

The development of recurrent CSF leakage with removal or blockage of the shunt is disconcerting, but there was only one shunt that became infected during the study and there were no cases of pneumocephalus. A recent review of the use of closed continuous CSF drainage from the lumbar subarachnoid gives results similar to those reported with use of an LP shunt, with over 90% of patients being successfully controlled but with a relatively high infection rate of 5% and a 3% incidence of overdrainage with temporary neurological decline (40).

Pseudotumor cerebri

LP shunting has traditionally been advocated as the surgical treatment of choice for medically refractory pseudotumor cerebri because of the ease of insertion of the shunt in the presence of small ventricles and the rapid normalization of ICP (1, 23, 24, 48). Although the results are usually very favorable, as seen in this study with 9 of 10 patients having rapid resolution of papilledema and headaches, others have reported visual loss in the presence of a functioning LP shunt and have advocated the use of optic nerve sheath fenestration (8, 15, 25–27, 34, 44). It is of interest that the high rate of malfunction seen in this study (7 of 10 patients requiring revision) is in keeping with other series with revision rates between 50 and 75% being reported (24, 26, 35). Low-pressure headaches seem a particular problem in this group of patients (24) with 4 of 10 patients of this series requiring a horizontal-vertical device. Delayed shunt malfunction resulting in the development of florid symptoms of raised ICP many years after shunt insertion has been previously reported (15, 24) and may represent shunt dependence (24) or may depict the natural history of the disease in a small subset of patients (34). This possibility of recurrence of symptoms has resulted in the majority of LP shunts being left in situ.

Unique complications

Spinal deformities consisting of scoliosis, lumbar hyperlordosis, and back stiffness with limited flexion have been previously reported (28, 31, 45) after LP shunting. In addition to these findings, paraplegia, neurogenic bladder, sciatica, and deformities of the lower limbs have also been noted (28, 31). Severe arachnoiditis was associated with the use of polyethylene tubing (17, 28, 31), and it was hoped that the use of silastic tubing would solve this problem (17). As this study shows, arachnoiditis does occur in the presence of silastic catheters, although it would appear to be less severe than that seen in the days of polyethylene shunts. Nonetheless, a significant percentage of patients in this study had evidence of spinal and nerve root involvement and 11 patients required removal of the shunt for this reason.

Although it is possible to envisage how local lumbar arachnoiditis may cause cauda equina nerve root problems, back pain, and even back stiffness and hyperlordosis (from paraspinal muscle spasm), it is more difficult to attribute the presence of scoliosis after LP shunting to arachnoiditis (28, 31). We have recently reported that tonsillar herniation may occur in up to 70% of patients after LP shunting (10) and have noted the well-documented association of Chiari I with syrinx formation and spinal deformity (12, 33); we therefore suggest that the occurrence of scoliosis in this setting may in fact be secondary to hindbrain herniation and that patients with scoliosis and an LP shunt be examined by magnetic resonance imaging.

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CONCLUSION

From this study, it is apparent that LP shunts used in the treatment of hydrocephalus function approximately as long and have certain advantages over other forms of CSF diversion. T-tube-type shunts remained free of malfunctions significantly longer than did the percutaneous type in this study; this partly reflects a particularly poor rate of malfunction for the percutaneous type in infants younger than 6 months of age and partly reflects a higher rate of shunt migration associated with the use of this shunt type. Obstruction, usually distal, was the most common cause of shunt failure, and by the end of the study, 31% of the patients with hydrocephalus had been converted to a VP shunt. LP shunts were also successful in dealing with CSF fistulae, although it would appear from this study that they have a limited role in the management of posterior fossa pseudomeningoceles. Although also successfully used in medically refractory pseudotumor cerebri, LP shunts used in this group of patients had a high rate of malfunctions and a few patients appear to have become shunt dependent.

The unique complications of arachnoiditis, scoliosis, and tonsillar herniation associated with this form of shunting are shown to be relatively common, and although surgical intervention has been rarely required, these complications should be borne in mind when considering LP shunt insertion and when monitoring patients with LP shunts.

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REFERENCES


**COMMENTS**

Lumboperitoneal shunting as opposed to ventricular shunting is quite appealing because it is more likely to maintain the integrity of the cerebrospinal fluid pathways, it does not require brain cannulation with the inherent risks of hemorrhage and seizures, and most reports have shown a lower infection rate. The authors of this article present a large series of carefully monitored and excellently studied patients undergoing lumboperitoneal shunting. The results were then compared with the complication and management success statistics from their own data on children undergoing ventricular shunting.

This technique can be used in situations where ventricular shunting is not appropriate, such as for cerebrospinal fluid fistulae and pseudotumor cerebri. For these indications, the procedure is extremely successful.

For patients with communicating hydrocephalus, however, the results of lumbar shunting are no better than those of ventricular shunting. The infection and failure rates are for the most part indistinguishable from those with ventricular shunts. The authors also report some serious complications that are unique to this form of shunting, including scoliosis (14%), back pain and stiffness, and sciatrica. Chronic tonsillar herniation occurred as a radiographic finding in 70% of patients and was symptomatic requiring suboccipital decompression in 5%. There was also a 6% incidence of neurological deficit in the legs. These last figures should be considered as potentially low estimates because patients with potentially confounding conditions were excluded.

From these data, it is clear that lumboperitoneal shunting is the treatment of choice for cerebrospinal fluid fistulae and pseudotumor cerebri, but because of the unique complications occurring in this form of treatment of hydrocephalus, it is unlikely that this should be the first form of treatment. One piece of data not available in this article, which would affect this decision, would be the incidence of seizures in this population as opposed to that in the ventricular shunt population. There is a growing concern that the presence of a ventricular catheter will lead to seizures merely by its presence. If patients with lumboperitoneal shunts had a significantly lower seizure risk, then this should be part of the decision-making process.

Harold L. Rekate
Phoenix, Arizona

The group from The Hospital for Sick Children has given us another important article on the management of hydrocephalus in children. I might rewrite their conclusion, however. The only true advantage of a lumboperitoneal shunt is when the cerebral ventricular system is not available, as in communicating hydrocephalus with slit ventricles or pseudotumor. Even then, because of the conversion of the child with pseudotumor to shunt dependence and the unique but unfortunate complication of lumboperitoneal shunts, the advantage is questionable. Lumboperitoneal shunts are not an option to ventricular shunts and should be used only when the cerebral ventricles are not accessible.

David G. McLone
Chicago, Illinois