Use of percutaneous endoscopy to place syringopleural or cystoperitoneal cerebrospinal fluid shunts

Technical note

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The authors describe a technique for percutaneous endoscopic shunt placement to treat clinically symptomatic spinal cysts. Seven patients underwent the procedure—five with syringomyelia, one with a symptomatic perineurial cyst, and one with a large arachnoid cyst. In all patients the shunt was successfully placed, and clinical improvement occurred in six. In four patients the entire procedure was performed endoscopically, whereas in three conversion to an open surgical exposure was required for safe access of a syrinx cavity. Overall, however, the pleural or peritoneal catheter was successfully placed endoscopically. In seven patients, there were two cases of postoperative positional headaches of which one required valve revision. In one case the catheter migrated and required repositioning. Percutaneous endoscopic shunt placement appears feasible in appropriately selected patients.

KEY WORDS • cerebrospinal fluid • percutaneous endoscopy • shunt • syringomyelia

Surgical treatment of spinal cord or nerve root cystic lesions may require extensive exposure and be time consuming and technically difficult especially in regions where surgery has previously been performed. In addition, it is often unclear if decompressing a cystic lesion will result in a clinical benefit. Therefore, minimal-access techniques to decompress cysts via shunting of fluid to body cavities are desirable. Endoscopy has been used for surgery of the vertebral column but its application in intradural procedures is limited and we found only one case of surgery involving a percutaneously introduced endoscope. Several groups have reported that laparoscopy facilitates abdominal placement of ventriculoperitoneal shunts, as has thoracoscopy helped in placement of a shunt in the pleural cavity. In our first case percutaneous shunt placement was the most reasonable option because it could be performed after administration of a local anesthetic. The myelotomy was performed using a spinal needle. Thereafter, endoscopically assisted shunt therapy for intramedullary syringes or intradural or perineurial cysts was performed to obviate the need for a laminectomy and to avoid conventional surgical exposure of the pleural or peritoneal cavity.

Clinical Material and Methods

Percutaneous endoscopy was conducted to demonstrate the spinal cystic cavity, the pleural or peritoneal cavity, or both in seven patients: five with clinically progressive syringomyelia, one with a thoracolumbar arachnoid cyst, and one with a large sacral perineural cyst (Table 1). All patients were men who ranged in age from 32 to 52 years. Preoperative MR imaging, CT scanning, and plain radiography, as indicated, were performed in all cases (Figs. 1 and 2). Preoperative coagulation profiles were normal in all patients. All patients received perioperative antibiotic agents, and perioperative somatosensory evoked potential/electromyography monitoring, if appropriate, was also conducted. The following presenting signs and symptoms were observed: cervical syringomyelia and an ascending neurological level (C3–4) complicating chronic quadriplegia (Case 1); a large perineural sacral cyst and severe back pain exacerbated by coughing (Case 2); a large thoracolumbar arachnoid cyst, progressive leg weakness, and sensory loss 10 years following ependymoma resection (Case 3); clinically progressive syringomyelia including sensory loss, worsening of autonomic symptoms, and progressive motor weakness (Cases 4–6); and worsening of autonomic symptoms and neuropathic pain (Case 7). Four of the five patients with syringomyelia had undergone previous decompressive interventions and were not deemed candidates for untethering, duraplasty, or further spinal cord decompression. In Case 5 there was clinically pro-

Abbreviations used in this paper: CSF = cerebrospinal fluid; CT = computerized tomography; MR = magnetic resonance; SCI = spinal cord injury.
Percutaneous endoscopic shunt placement

Surgical Technique

Placing the Drainage Catheter Into Syringomyelic Cavities. Under fluoroscopic guidance, a 14-gauge Touhy needle was introduced into the epidural space by using the loss-of-resistance technique and a Myelotec 0.9-mm-diameter endoscope (Model 3000E; Visionary Biomedical, Inc., Roswell, GA) and advanced through the needle to demonstrate the dura mater prior to entering the subarachnoid space with the needle. The endoscope was attached to a Storz digital camera, and the signal was displayed on a Sony color monitor. Visualization of the epidural space improved orientation to the midline because if the needle was rotated to the left or the right and the endoscope advanced, then the nerve root sleeves could be observed. Therefore, a combination of anteroposterior fluoroscopy and being equidistant from the lateral nerve roots served as a reference to the midline. The needle was then fluoroscopically advanced through the dura over the endoscope until CSF was returned and the subarachnoid space was observed using the endoscope (Fig. 3A). At this point the spinal cord vasculature and nerve rootlets could be seen, again facilitating orientation to the midline. Any visible vessels were avoided and the pia mater was penetrated to enter the cyst. We were careful to control CSF drainage to prevent the cyst from collapsing prematurely. This was facilitated by connecting a three-way stopcock to the Touhy needle for preservative-free saline infusion. During epidural and subarachnoid endoscopy, visualization was facilitated by pulsatile irrigation of small volumes of sterile saline. Localization within the cyst cavity was confirmed by reinserting the endoscope via the needle and identifying the cyst wall. A myelogram or cystogram was obtained to provide additional verification of localization within the cyst and of communication in patients in whom septations were present within the syrinx (Fig. 4). In some patients the site of perforation in the spinal cord could be observed by backing the needle and endoscope out 3 to 4 mm (Fig. 3B). The endoscope was then removed, the shunt catheter was advanced through the needle, and the shunt tip demonstrated fluoroscopically. Another myelogram or cystogram was obtained through the tubing to verify that the shunt tubing was within the cyst. In all cases we used a Medtronic PS Medical (Goleta, CA) barium-impregnated lumbar catheter shunt, which was cut to the appropriate length in each case. The sleeve to anchor the tubing was placed at the site of the needle puncture by extending the skin perforation into a 1-cm incision. The

**TABLE 1**

Summary of pre- and postoperative details obtained in seven patients undergoing shunt placement

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Clinical Presentation</th>
<th>Lesion Level</th>
<th>Procedure</th>
<th>Aspect Performed Endoscopically</th>
<th>Outcome</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>progressive posttraumatic syringomyelia w/ as- cent of quadriplegic level &amp; decreasing vital capacity</td>
<td>C1–T4</td>
<td>percutaneous fenestration of syrinx &amp; placement of SP shunt</td>
<td>entire op</td>
<td>improvement in vital capacity; stable at 2.5 yrs</td>
<td>migration of syrinx catheter out of syrinx &amp; need for revision of proximal shunt</td>
</tr>
<tr>
<td>2</td>
<td>large perirenal S-1 cyst; LBP exacerbated by cough &amp; Valsalva</td>
<td>S-1</td>
<td>shunting of sacral cyst to peritoneum</td>
<td>entire op</td>
<td>resolution of LBP; stable at 2 yrs</td>
<td>mild transient positional headaches</td>
</tr>
<tr>
<td>3</td>
<td>large arachnoid cyst following ependymoma resection</td>
<td>T11–L3</td>
<td>trial of external drainage of large arachnoid cyst</td>
<td>entire op</td>
<td>no definite change in symptoms</td>
<td>none</td>
</tr>
<tr>
<td>4</td>
<td>progressive posttraumatic syringomyelia</td>
<td>C6–T4</td>
<td>SP shunt; converted to lam†</td>
<td>pleural cavity catheter placement</td>
<td>stable improvement at 1.5 yrs</td>
<td>none</td>
</tr>
<tr>
<td>5</td>
<td>progressive idiopathic syringomyelia</td>
<td>C2–T7</td>
<td>SP shunt; converted to lam†</td>
<td>pleural cavity catheter placement</td>
<td>stable improvement at 1.5 yrs</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>progressive posttraumatic syringomyelia</td>
<td>C1–T12</td>
<td>SP shunt</td>
<td>entire op</td>
<td>clinical improvement stable at 1.5 yrs</td>
<td>intractable positional headaches; valve placed</td>
</tr>
<tr>
<td>7</td>
<td>progressive posttraumatic syringomyelia</td>
<td>C5–T12</td>
<td>SP shunt; converted to lam†</td>
<td>pleural cavity catheter placement</td>
<td>decrease in neuropathic pain &amp; reduced autonomic symptoms; stable at 1 yr</td>
<td>none</td>
</tr>
</tbody>
</table>

* lam = laminectomy; LBP = low blood pressure; SP = syringopleural.
† Converted to a laminectomy because the subarachnoid space could not be adequately demonstrated.
sleeve was secured to the tubing with silk ties and sutured to the subcutaneous tissue.

Nerve Root or Spinal Arachnoid Cysts. In patients requiring nerve root or arachnoid shunts, normal anatomy is not present. Fluoroscopy was used to establish the proper level, and the extradural space was again demonstrated endoscopically prior to dural entry. Following dural entry of the nerve root cyst, a large featureless cavity was seen. Localization within the cyst was confirmed using a small injection of radiopaque contrast. In the case of the arachnoid cyst the lesion was observed as separate from the spinal cord, and it was safely penetrated with the spinal needle.
Placing a Valve or Reservoir. A 4- to 5-cm skin incision was made just lateral to the midline to allow placement of the reservoir or valve in all cases except that in Case 3. This incision was used to introduce the shunt tunneling device, which was directed to a third 2-cm incision over a rib or the peritoneal cavity.

Thoracic or Peritoneal End of the Catheter. In intubated patients in whom general anesthesia had been induced, the ventilator was held at the end of the expiratory cycle and the Touhy needle was advanced over a rib. The endoscope was used to demonstrate the pleural space and the distal portion of the catheter fed through the needle into this...
space. In the case requiring a nerve root cyst shunt, the skin overlying the peritoneum was pinched and the Touhy needle was carefully advanced until there was loss of resistance to pressure from an attached glass syringe. Five to 10 milliliters of saline was injected, and the endoscope was then advanced through the needle to reveal the intraperitoneal viscer. The shunt tubing was passed through the needle, which was then removed, and the intraperitoneal or pleural position of the tubing was verified fluoroscopically.

Results

There were no serious complications. All patients improved except for one (Case 3) in whom an intracystic lumbar drain was placed using the percutaneous endoscopic technique. This patient was observed in the hospital for 3 days, and decompression of the cyst was confirmed radiologically; however, there was no objective change in his symptoms of sensory loss and motor weakness, and drainage was discontinued. In all cases the intention was to perform the entire procedure endoscopically but this was achieved only in four patients. In two cases of syringomyelia the site of posterior perforation in the spinal cord exhibited a pulsatile billowing appearance very similar to that observed during a third ventriculostomy. Bleeding was minimal and when it occurred it cleared following a few minutes of irrigation. Overall blood loss was negligible in the patients in whom the entire procedure
was performed endoscopically. In the patient in Case 1 it was not possible to enter the subarachnoid space via the posterior approach because of the presence of an extensive fusion mass, and thus the subarachnoid space was entered via a posterolateral approach (Fig. 1C). This patient experienced an increase in forced vital capacity from 1.1 to 2 L within 24 hours of surgery. Thirty days after shunt placement, he became symptomatic again, and imaging studies revealed migration of the shunt catheter out of the syrinx. This was believed to be due to inadequate securing of the tubing within the subcutaneous space, and the proximal shunt was revised after administration of a local anesthetic. The patient improved and has been clinically stable for 2.5 years. The patient in Case 6 suffered position-related headaches that did not resolve after several days. He was returned to the operating room where the reservoir was switched to a medium-pressure antisiphon valve. Following this intervention, the low-pressure headaches resolved. The patient in Case 2 also experienced transient mild position-related headaches but these resolved after approximately 3 weeks. We think the headaches are unrelated to the endoscopic procedure but are common, usually transient, after syringopleural shunt placement. In Cases 4, 5, and 7 we converted the procedure to a laminectomy when we found that the visualization of the spinal cord was suboptimal.

**Discussion**

The advantages of an endoscopically assisted shunt procedure are that it can be performed using a local anesthetic if necessary. This form of anesthetic is simpler to administer in patients with a complete SCI when the cyst and chest or peritoneal entry sites are below the neurological level. If a local anesthetic is used, it is critical that the patient not move during the process of cyst perforation. Marked distortion of the subarachnoid space makes the procedure more difficult because orienting anatomical landmarks are absent. Thus far we have only performed the procedure if the epidural and subarachnoid spaces could be well seen. This quality of visualization helps prevent deviation from the midline to avoid nerve root sleeves, allows avoidance of surface blood vessels, and, in most cases, permits visualization of the cyst prior to perforation with the needle. Therefore, cases involving tethered spinal cords and those in which the subarachnoid space is not open because of scarring may be inappropriate for this technique unless the cyst can be entered at a level where such scarring is not present. Additionally, because it is more difficult to conduct this technique at a site of previous laminectomy, we prefer to enter the spinal canal through an intact posterior interspinous space. In the patient in Case 5 there was no subarachnoid scarring, but we thought the quality of endoscopic visualization was inadequate for accurate midline localization and so converted the procedure to a laminectomy exposure. This decision was influenced by the fact that the patient’s SCI was incomplete. A 14-gauge needle has an outer diameter of 2.1 mm, which is smaller than a typical myelotomy for catheter placement. Therefore, the technique could be considered for use in patients with incomplete SCI, but we recommend that this only be done if the visualization is excellent and if the surgeon has acquired some experience in less challenging cases. Because it takes only a few minutes to obtain the initial endoscopic view, little time is added to the procedure if conversion to laminectomy is necessary. We believe the potential to avoid a laminectomy confers a significant benefit to the patient. Fenestration of the
syrinx itself may be useful to promote CSF flow out of the syrinx, and the similarity of the appearance during the procedure to third ventriculostomies is striking. The My- celotec 1-mm endoscope does not have a working channel. A working channel scope would have some advantages such as allowing direct demonstration of the catheter placement; however, its larger diameter would require the use of a trochar to access the epidural space, and, if introduced into the subarachnoid space, the durotomy would be quite large and there would be a risk of chronic CSF leakage into the epidural space. Because a suture cannot be placed around the catheter at the pia mater, it is even more important that the tubing sleeves be adequately secured in the subcutaneous tissue. Care must be taken to avoid inadvertent perforation of the lung or the abdominal viscera; we are exploring the use of blunt-ended small-diameter cannulated trochars for this purpose. We have used an adaptation of this percutaneous endoscopic technique to perform cellular transplants in pigs and suggest that an endoscopic technique might be useful for cell or tissue transplantation as an alternative to shunt placement in syringomyelia.

Conclusions
Percutaneous placement of shunts from spinal cysts to the pleural or peritoneal cavity is feasible in selected patients and can reduce the need for extensive surgical exposure and allow the clinical impact of cyst decompression to be determined. Both the spinal cyst and the abdominal or thoracic cavity can be accessed endoscopically in appropriate cases.

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Disclaimer
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References