Minimally invasive technique for insertion of ventriculopleural shunt catheters

Technical note

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Object. Cerebrospinal fluid diversion to the pleural space has employed various methods to insert the distal catheter into the pleural space. The authors report on a minimally invasive method of pleural catheter insertion that they have developed and have used safely in a small series of patients.

Methods. Pleural shunt catheters were inserted using a split trochar into the pleural space (technique described in further detail in the article). All cases over the previous 10 years in which this technique was employed were reviewed from the existing electronic medical records. Patient age at insertion, sex, reason for hydrocephalus, early and late complications, valve type, and follow-up were recorded.

Results. Fourteen shunt procedures performed in 10 patients were identified. Two small pneumothoraces were detected on routine postoperative imaging and required no intervention. There were 3 late mechanical complications, including migration of a catheter out of the pleural space, catheter fracture at the insertion point, and the need for a longer catheter due to the patient’s growth.

Conclusions. The authors describe a safe, minimally invasive method for insertion of pleural shunt catheters along with a series of patients who have undergone placement of a pleural shunt catheter using this method without complication directly attributable to the use of this technique.

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KEY WORDS • shunt • pleural • ventriculopleural • minimally invasive • hydrocephalus

CEREBROSPINAL fluid shunting typically diverts CSF from the ventricular system of the brain to the peritoneal cavity, although historically, numerous other sites have been proposed as a terminus. For most patients, shunting to the peritoneal space provides CSF absorption in an area of the body that is easily capable of absorbing the output from the ventricular system. However, some patients cannot be treated with peritoneal CSF diversion due to infection, adhesions that lead to a decrease in the resorptive surface area of the peritoneum, or other coexisting medical conditions. In these cases, alternative sites for CSF shunting must be sought.

Shunting CSF to the pleural space has been used since at least 1914 when it was first described in the German literature by Heile.⁶ When described in published reports, placement of the distal shunt catheter into the pleural space has generally been performed via thoracotomy. In more recent years, a thoracoscopic approach to placement of the distal catheter has been described.¹⁰,¹¹

Here we describe a method of placing a pleural shunt catheter that provides access to the pleural space without the need for thoracoscopy or open thoracotomy and report a small series of the cases from our institution in which patients have been treated with ventriculopleural shunt placement by the senior author using this technique.

Technique

Patients are placed in a supine position. After establishment of proximal flow through a valve with an antisiphon device, a small (1.5- to 2-cm) incision is made in the midaxillary line at the level of the 3–4 intercostal space, and the distal tubing is brought to it subcutaneously. The tubing is cut to provide approximately 30 cm of intrathoracic length. A combination of blunt dissection and monopolar electrocautery is used to open the subcutaneous tissues to the level of the intercostal muscles. A pointed trocar and channeled sheath (the same trocar we use for placement of ventriculoperitoneal shunts, Codman disposable split trocar) is then placed on the lower palpated rib and is slid superiorly to the intercostal muscle at the edge, without direct visualization. The anesthesiologist allows for maximal exhalation, letting the lung deflate passively. Using a controlled force, the trocar is then inserted, on a horizontal trajectory “parallel to the floor,” through the intercostal muscles until it can be felt to penetrate into the pleural space. The trocar is removed and the distal tubing passed into the chest through the sheath. Continuous irrigation onto the split sheath is provided by an assistant while the anesthesiologist then inflates the lungs with a Valsalva maneuver. Continuous irrigation is maintained.
over the split sheath with the distal catheter in it for repeated breaths and Valsalva maneuvers until air bubbles cease to escape from the pleural space. With another Valsalva maneuver and under continuous copious irrigation, the split sheath is removed, taking care not to withdraw the catheter and not to shear it on the edge of the open channel. The soft tissues form a seal around the flexible catheter, and the subcutaneous tissue and skin is closed in at least 3 layers. An upright chest radiograph is obtained immediately in the recovery room, and upright anteroposterior and lateral chest radiographs are obtained the day after the operation, before discharge from the hospital.

Case Series

The Colorado Multiple Institutional Review Board approved the retrospective collection of data for this case series. Among all shunt surgeries performed over the last 8 years by the senior author (M.H.), procedures undertaken for placement of a new shunt or for distal revision to a pleural terminus were identified. The patients’ age at the time of pleural shunting, complications, diagnosis, and operative report were reviewed for consistency of technique in placing the pleural catheter. Among 107 new shunt procedures and 68 revisions, 14 ventriculopleural shunt procedures were performed in 10 patients (Table 1). It has been our practice virtually never to attempt or offer a pleural terminus in children under 7–8 years of age, or roughly 25 kg. There were no acute complications after shunting: 2 patients had small pneumothoraces, barely detectable on the routine postoperative radiograph, which were asymptomatic and required no intervention.

Patients averaged 15.7 years of age at the time of surgery, with the youngest patient being 5 years old and the oldest 29 years old. There were no infections. There were 3 late mechanical complications. A catheter migrated out of the pleural space into the subcutaneous tissues after several months. One catheter separated at the point of insertion into the chest. One patient grew sufficiently that the tip of the pleural catheter withdrew into the subcutaneous tissues after 8 years.

Discussion

The peritoneal space has proven to be the most reliable terminus for a ventricular shunt, and is the most common. At times, however, local complications preclude its use. We have found that ventriculopleural shunting is a viable alternative after failure of ventriculoperitoneal shunting or when ventriculoperitoneal shunting is otherwise contraindicated. Indeed, it is our routine second option in children who are large enough. Two commonly used other loci, the right atrium and gallbladder, have their own problems. Vascular shunts have the problem of malposition as a child grows, sepsis in the setting of infection, and intracardiac migration of the distal catheter in the event of distal catheter fracture. Placing a shunt into the gallbladder is technically more complicated.

The literature on ventriculopleural shunts has generally supported their use in older patients. Venes and Shaw observed that pleural shunts should be reserved for children 8 years of age and older, a practice we have followed, although others have used them in younger patients. For our 5-year-old patient, concern for bacteremia from a long-term indwelling central venous catheter prompted our decision to avoid an atrial terminus; he tolerated the ventriculopleural shunt well.

None of the 14 procedures produced any immediate operative complication as a result of using a split sheath and trocar to enter the pleural space. The pneumothoraces we observed were small and not unexpected; furthermore, they are frequently seen after open placement of pleural shunts as well. It is our belief that this technique reduces the risk of larger collections of air. Since the tract is quite a bit smaller than in an open procedure, this technique also may provide a more effective barrier against air and fluid potentially leaking from the pleural spaces into the subcutaneous tissues, which has been reported with an open technique. Our technique requires only a small skin incision in the midaxillary line, to which point a shunt catheter can be tunneled; thereafter, the split trocar is used to enter the pleural space without the need for open thoracotomy. The smaller puncture point decreases the risk for pneumothorax as there is less potential for air to enter the pleural space. When the split sheath is removed, the tissue around the catheter provides a natural barrier to air that otherwise would have free access to the pleural space during closure of an open thoracotomy. It also theoretically provides more resistance to catheter migration out of the pleural space, a well-described complication, though we did see this occur in one of our patients. The trocar is sufficiently blunt that injury to the lung was not seen. The point of entry and trajectory also minimize the risk and are placed in a manner analogous to percutaneous placement of a chest tube, which is routinely performed in the management of thoracic trauma, in or in placement of a port for thoracoscopy.

The patient with disruption of the catheter at the point of insertion into the chest likely had a partial tear or weakening of the catheter as the sheath was removed during the insertion process, which we have seen happen with catheters inserted with a trocar into the peritoneum as well, and which has not been observed with open catheter placements.

Thoracoscopic placement of the distal pleural catheter offers the benefit of direct observation of catheter entrance into the pleural space and allows the surgeon to confirm the viability of the pleural space with respect to adhesions. While the thoracoscopic approach is less invasive than an open technique to access the pleural space, it is more invasive than our described technique in requiring 2 points of entry to the chest, one for the camera and the other to insert the catheter. Indeed, our technique is virtually the same as the technique used to place thoracoscopic ports. Thoracoscopy is a superfluous addition of complexity with little added benefit; we simply could not conceive of a rationale for direct observation of the passage of the catheter into the pleural space, an opinion which was shared by our general surgery colleagues, who advised against thoracoscopy.
Conclusions

Using a trocar and split sheath for pleural catheter placement is a minimally invasive approach to the pleural space. Quick and simple, it has few complications and is a good alternative when the peritoneal space is in hospitable and entails fewer problems than use of a vascular terminus.

Acknowledgment

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Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: both authors. Acquisition of data: Richardson. Analysis and interpretation of data: Richardson. Drafting the article: Richardson. Critically revising the article: both authors. Reviewed submitted version of manuscript: both authors. Approved the final version of the manuscript on behalf of both authors: Richardson. Administrative/technical/material support: Richardson. Study supervision: both authors.

References


### TABLE 1: Characteristics of 10 patients undergoing 14 shunt procedures*

<table>
<thead>
<tr>
<th>Pt No.</th>
<th>Pt Age (yrs) at Op, Sex</th>
<th>Etiology of Hydrocephalus</th>
<th>Acute Complication</th>
<th>Late Complication</th>
<th>FU/Time to Revision</th>
<th>Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16, F</td>
<td>posthemorrhagic</td>
<td>none</td>
<td>none</td>
<td>27 mos</td>
<td>Novus low pressure</td>
</tr>
<tr>
<td>2</td>
<td>12, F</td>
<td>spina bifida</td>
<td>none</td>
<td>none</td>
<td>31 mos</td>
<td>Novus low pressure</td>
</tr>
<tr>
<td>3</td>
<td>14, M</td>
<td>posthemorrhagic; tiny pneumothorax needed no intervention; pt home postop Day 1</td>
<td>none</td>
<td>catheter migrated out of pleural space, revised 3 wks later</td>
<td>lost to FU after 1 wk</td>
<td>Delta 1.0</td>
</tr>
<tr>
<td>4</td>
<td>9, M (rt shunt)</td>
<td>posthemorrhagic</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>3 wks</td>
<td>Novus low pressure</td>
</tr>
<tr>
<td>5</td>
<td>26, M</td>
<td>spina bifida</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>4 wks</td>
<td>Novus low pressure</td>
</tr>
<tr>
<td>6</td>
<td>19, M</td>
<td>spina bifida</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>85 mos</td>
<td>Delta 1.0</td>
</tr>
<tr>
<td>7</td>
<td>17, M</td>
<td>spina bifida</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>4 mos</td>
<td>Novus low pressure</td>
</tr>
<tr>
<td>8</td>
<td>10, M</td>
<td>posthemorrhagic</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>lost to FU</td>
<td>Novus low pressure</td>
</tr>
<tr>
<td>9</td>
<td>29, M (lt shunt)</td>
<td>posthemorrhagic</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>96 mos</td>
<td>Delta 1.0</td>
</tr>
<tr>
<td>10</td>
<td>5, M</td>
<td>spina bifida</td>
<td>none</td>
<td>catheter fractured at insertion site</td>
<td>55 mos</td>
<td>Delta 1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21 mos</td>
<td>Delta 1.0</td>
</tr>
</tbody>
</table>

* FU = follow-up; pt = patient.

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