The Role of the Thoracic Surgeon in Distal Catheter Placement

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Background	A 54-year-old male with a history of aneurysmal subarachnoid hemorrhage s/p VP shunt required revision to VPL shunt due to shunt infection.
Summary	For the operative management of hydrocephalus, cerebrospinal fluid (CSF) is diverted from the cerebral ventricles to an alternative resorptive part of the body, commonly the peritoneum via ventriculoperitoneal (VP) shunts, the atria via ventriculoatrial (VA) shunts, or the pleural cavity via ventriculopleural (VPL) shunts. The optimal site is chosen based on coexisting medical conditions. In this article, we will describe our minimally invasive method of establishing a VPL shunt as well as the benefits and risks of this procedure. To manage hydrocephalus, we detail indications and risks for VPL shunts along with our method of thoracoscopic placement under direct visualization.
Conclusion	VPL shunts demonstrate a relatively low complication rate compared to other shunts and provide a viable option with low operative morbidity/mortality plus preserved long-term effectiveness.
Key Words	VATS; surgery techniques; shunts; ventriculopleural shunt; hydrocephalus; thoracic

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Case Description

The patient is a 54-year-old male with PMH of aneurysmal subarachnoid hemorrhage treated with coiling and craniectomy complicated by hydrocephalus and treated with placement of a VP shunt. This VP shunt developed a *Pseudomonas* infection, necessitating its removal and subsequent replacement with a new ventriculostomy catheter and external ventricular drain. Following treatment of the *Pseudomonas* infection, the patient presented for definitive placement of a VPL shunt.

The patient was placed in the supine position. Proximal cranial access was then achieved with the neurosurgery team's confirmation of cerebrospinal fluid flow through the ventricular shunt tubing. A cerebrospinal fluid (CSF) manometer may also be used to confirm pressures before proceeding to the thoracic portion of the case. Following confirmation of cranial access with CSF flow, the tubing was then tunneled over the anterolateral right chest wall to the fifth rib lateral to the midclavicular line. The thoracic surgeon then made a small 1 cm skin incision overlying the sixth rib in the mid-thoracic cavity line, and a 5 mm port was placed into the thoracic cavity. Through this port, CO_2 insufflation began at 8 mm Hg pressure. Subsequently, a 5 mm thoracoscopic camera was used to inspect the thoracic cavity to exclude gross intrathoracic pathology, adhesions, or other contraindications to a VPL shunt placement. A peel-away introducer was then placed within the original incision, 3 mm medial to the port. The shunt tubing was tunneled out of the incision, placed through the peel-away sheath catheter, and directed to the apex of the right chest under direct vision. After 40 cm of tubing was confirmed in the pleural space, CO_2 insufflation was terminated, and the lung was inflated with 20 cm Hg Valsalva breaths while instilling water over the 5 mm port. The 5 mm port was removed when no additional air bubbles were appreciated. The incision was closed in layers with Vicryl suture, and a chest radiograph was ordered to confirm proper catheter position and the absence of pneumothorax.

Discussion

Currently, ventriculoperitoneal (VP) shunts are the preferred first-line operative management of hydrocephalus due to the large resorptive area of the peritoneal lining, relatively low complication rates, and long-term reliability. Ventriculopleural (VPL) shunts are the second most common treatment choice. They are usually performed when comorbid medical conditions preclude the use of peritoneum as a resorptive area, such as the presence of adhesions, abdominal pathology, pregnancy, or recent VP shunt infections.[1,2]

The main complication related to VPL shunts is pleural effusions; however, many are treated with observation alone without shunt removal.[3] In multiple case series reviews, patients that had large pleural effusions underwent thoracentesis with successful fluid removal while keeping the catheter in place.[4,5] In pediatric patients, one case of acute respiratory failure required the removal of the VPL shunt.[6] It has been appreciated that pediatric patients are not ideal candidates due to the limited absorptive capacity of their smaller pleural cavities.[4,5] An antisiphon device can be placed on the tubing to prevent additional CSF shunting to the pleural cavity to address this issue of effusion in both pediatric and adult populations. With this reduction in CSF shunting, the surgeon must remove an adequate amount of fluid to prevent hydrocephalus. There has been one case report where positive pressure ventilation has caused a distal catheter obstruction leading to neurological depression; however, it is rarely described in the literature. Symptoms did improve after the removal of positive pressure ventilation. One possible method to avoid this issue could be placing one-way valves on the catheter, which has been effective when insufflating for laparoscopic cases with VP shunts.[4,5]

Regarding VP shunt infections, the Infectious Diseases Society of America guideline recommends tailoring antibiotic regimens per individual case. Overall, empiric treatment with antibiotics and then removal of the shunt and culture is first-line. If the patient continues to be septic, an intraventricular antibiotic can then be considered. Duration of antibiotics and timing of new shunt placement are also individualized per the type of pathogen found on culture.

In our experience, we have placed six VPL shunts in the last several years with good results. Each case was due to hydrocephalus for different reasons, with two requiring direct placement of VPLS due to contraindications to VPS and two requiring conversion from VP shunts to VPL shunts. For all cases, we placed shunts without needing a chest tube or finding pneumothorax postoperatively on chest X ray. We report one case with trace pleural effusion that was observed and subsequently resolved without issues.

With advances in endoscopic technology, VPL shunts can now be performed utilizing one small incision without the placement of chest tubes. Some groups will routinely place VPL shunts without the use of a thoracscopic 5 mm port insertion.[6] Our method of placing VPL shunts has the added benefit of visualizing the thoracic cavity and confirming the placement of the catheter itself. Other groups doing similar techniques also confirm this advantage which allows minor manipulation of the shunt tubing, reduces the risk of damage within the pleural cavity and verifies appropriate function.[7] Furthermore, it reduces mechanical causes of shunt failure, including obstruction, retraction, and kinking of the catheter. Finally, with adequate Valsalva during closure, chest tube placement is unnecessary.

Other new and interesting methods of placing VPL shunts include ultrasound-guided percutaneous VPL shunt placement.[8,9] This allows avoidance of an operative procedure; however, direct visualization of placement location and absence of intrathoracic pathology would not be able to be confirmed. Losing visualization will cause an increased risk of shunt malfunction, which may require another operative procedure.

Conclusion

VPL shunts have been shown through many case series to be an excellent option for shunting CSF that is safe and comparable to VP shunts. We propose an operative method of Visiport thoracoscopic visualization and split sheath pleural catheter to place VPL shunts safely under direct vision without chest tubes.

Lessons Learned

VPL shunts are important options to reduce intracranial pressure for hydrocephalus in situations where abdominal pathology makes VP shunts contraindicated.

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