A novel solution to reduce the complications of distal shunt catheter displacement associated with obesity

Report of 3 cases

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Despite the varied sources of hydrocephalus, all shunt-treated conditions involve redirection of CSF to the body, commonly the peritoneum. Migration of the distal catheter tip out of the peritoneal space can occur, leading to the need for reoperation. Although uncommon, the authors have recently had 3 such cases in obese patients involving distal tubing retropulsion in otherwise uncomplicated surgeries. In addressing this issue, the authors performed anchoring of the distal catheter tubing through a small abdominal mesh, which is commonly used for hernia repair to increase catheter tube friction without compromising CSF flow. The results suggest this method may mitigate the chance of peritoneal catheter displacement in patients with higher than normal intraabdominal pressure.

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Key Words • ventriculoperitoneal shunt • shunt revision • distal catheter placement

Ventriculoperitoneal shunt placement has routinely been performed since the 1950s following the first working shunt valve developed by Holter and Spitz. However, despite procedural and equipment advances, the procedure continues to be plagued by a myriad of complications. Among the most prevalent (occurring in 8.6% of shunt-treated patients) and morbid of these complications is distal shunt tip migration out of the abdomen, resulting in CSF collection in the anterior rectus space. We describe 3 recent cases involving displacement of the distal tip from the peritoneum to the subcutaneous space of the abdominal wall, occurring soon after surgery, in patients who all had high BMI (> 30). This complication in obese patients has been previously reported, but in our series was treated successfully in all 3 cases by threading the VPS catheter through a polypropylene and expanded polytetrafluoroethylene hernia patch (Ventralex, Bard). The mesh, secured to the peritoneal wall, served to increase the friction of the VPS catheter through the abdominal wall, preventing backing out of the catheter with elevated IAP.

Case Reports

History and Examination

These 3 patients suffered from abnormal ventricular physiology (2 with NPH, and 1 with pseudotumor cerebri) and required VPS catheter placement for treatment. All patients were obese with BMI > 30 (BMs 31, 40, and 43). Each patient presented postoperatively with a pseudomeningocele of the anterior abdominal region in the epi-peritoneal space. During each original surgery, the catheter tip was placed in the peritoneum under direct visualization of the bowel through a peritoneal opening of no larger than 1 cm. No other patients undergoing VPS procedures by the same surgeon during this period had either a BMI > 30 or retropulsion of the distal tubing.

Case 1. This 74-year-old man (6’0”, 250 lbs, BMI 30.5) underwent VPS placement for NPH. The patient had undergone 2 prior failed distal catheter revision attempts, with assistance of general surgery for peritoneal dissection. Within a month of the most recent revision attempt, abdominal pain and swelling developed, and a noncontrast abdominal CT scan revealed shunt tubing in the anterior abdominal wall with fluid collection (Fig. 1A).

Case 2. This 69-year-old man (6’0”, 300 lbs, BMI 42.6) underwent VPS placement for NPH. Several weeks later, he noticed swelling and peri-incisional pain. Noncontrast abdominal CT scan revealed shunt tubing in the anterior abdominal wall with fluid collection (Fig. 1B).

Case 3. This 38-year-old woman (5’8”, 265 lbs, BMI 40.3) suffered from pseudotumor cerebri for which a VPS was placed. Prior revision of the proximal and distal tubing was undertaken due to tethering in the neck as well as to ensure peritoneal placement. Several weeks thereafter, peri-incisional pain and swelling developed. Noncontrast abdominal CT scanning revealed a distal catheter tip mi-
Operative Technique

The previous abdominal transverse skin incision was opened into the CSF-filled cavity and the VPS catheter was identified. Care was taken not to incise the catheter tubing during opening of the cavity. To increase resistance of the catheter tip, and hoping to prevent retropulsion from the peritoneal cavity, a series of small holes was made in the strap of a polypropylene hernia patch; the catheter tip was pushed through the strap of the patch in serpentine fashion to provide further friction and resistance to longitudinal force. The catheter tip was then transitioned to pass through the superficial layer of the patch and then through the deeper layer of the patch, finally being fed into the peritoneal cavity under direct visual guidance through the outer layer of the patch and then, after a brief transverse segment, through the inner layer of mesh (Fig. 2 upper). In Case 1, the hernia patch was positioned intraperitoneally. In Cases 2 and 3, the patch was positioned extraperitoneally directly over the opening into the peritoneal cavity (Fig. 2 lower). The hernia patch was sewn in position using 4-0 Prolene parachuted mattress sutures. The cavity was imbricated and the wound closed in normal 2-layer fashion.

Postoperative Course

At routine follow-up appointments (2, 4, 6, or 8 weeks postoperatively) none of these 3 patients had symptoms of repeat catheter tip migration. In Case 1, gait instability and urinary incontinence had resolved acceptably; in Case 2, gait dysfunction and mental status had improved and headaches decreased; and in Case 3, neck and shoulder pain had resolved. No procedural complications or catheter tip migration recurrences have been observed to date. All patients have been seen beyond 12 months after surgical repair.

Discussion

These results suggest that weaving the distal catheter tip routinely through a small synthetic mesh in VPS placement could anchor the distal VPS catheter more securely to the abdominal wall and prevent future retropulsion in patients prone to distal catheter complications. The mesh material allows for increased friction along the catheter tubing and anchoring to the abdominal wall, resulting in a higher frictional resistance to IAP.

Patients with a high BMI are prone to elevated IAP and hence an increased propensity for distal VPS tubing to move from the peritoneal cavity to the anterior abdominal wall. A positive, linear relationship between BMI and IAP has previously been reported (r = 0.52, slope 0.31), and IAP should be considered when determining shunt-valve pressure selection in nonadjustable valves to prevent underdrainage of CSF. Furthermore, in the setting of a VPS, the distal catheter tip passing through the anterior abdominal wall might serve as a one-way “ratchet” for abdominal pressure. That is, IAP may push the distal catheter out of the abdominal cavity with no opposing force or mechanism serving as a counterforce. Over time, the sum of many subtle migrations in the distal catheter tubing, initiated by excess IAP, results in retropulsion of...
the entire distal catheter tip and pseudomeningocele formation.

Likewise, in patients with a high BMI, a larger connective tissue space exists in which the distal catheter may reside asymptomatically. This results in presentation of the pseudomeningocele later, which may be problematic for several reasons. First, the catheter function is impaired by the increased fluid-flow resistance at the distal end. Second, accumulation of CSF in the subcutaneous space in the abdominal wall is uncomfortable and provides a possible nidus for CSF infection or wound erosion.3,8

Additionally, catheter tubing is made from silicone that is hypoallergenic and allows for flexibility but also is prone to microscopic cracks and infection. Recently, shunt companies have introduced distal catheters with hydrophilic surfaces (for example, Medtronic’s BioGlide) to reduce tissue damage during distal catheter insertion, prevent catheter fracture, and reduce catheter-associated infection. While this modification does beneficially reduce the rate of infection in experimental studies, in fact, reducing bacterial colony counts by a factor of 2 log units, and while it decreases the rate of calcium deposition on the catheter (thus reducing the risk of fracture), it also decreases in the coefficient of friction from 0.6 to 0.2 (a 66% reduction in friction). Indeed, this change in friction coefficient aids in prevention of fibrous scar formation.1 However, BioGlide catheter tips also, problematically, make the distal tip more prone to retropulsion in the presence of obesity-associated IAP.7

Revision of failed distal catheters through a previous laparotomy incision can result in repeated retropulsion or incisional hernia.3,6,12 Anatomical reconstruction of the anterior abdominal wall with polypropylene mesh is routinely performed by general surgeons for hernia repair, often entirely with, or with the assistance of, a laparoscope (though not in this study). Infection risk when using mesh in abdominal hernia repair is slightly increased, in comparison with suture repair, and has been reported to have a relative risk of 0.09 (range 6.5%–10%).6,11 The recurrence rate, however, is increased in suture repair compared with mesh, with a relative risk of 1.85 (rates of 33.3% and 16.4%, respectively). Moreover, a cost analysis study concluded that the use of mesh was more cost effective and represents a lower risk of reoperation.5

The addition of mesh to a distal shunt revision represents a unique technique with commonly available and safe equipment at little or no increase in operative time or procedural cost ($600 for the mesh used) and prevents repeated distal catheter failure or incisional hernia. We speculate that, given the increased IAP and decreased coefficient of friction in newer catheter designs, this technique might be considered in the initial placement of the ventriculoperitoneal shunt in patients with high BMI, perhaps using a uniquely designed piece of mesh.

Conclusions

The present study supports using synthetic polypropylene mesh placement in patients with elevated BMI in whom distal catheter retropulsion has occurred—or initially, to prevent such occurrences at all. These results support further investigation and possibly a randomized controlled trial for analysis of risk reduction.

Disclosure

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

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