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Technical Notes

Distal catheter fixation in ventriculoperitoneal shunt by videolaparoscopy – Technical note

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ABSTRACT

Background: Ventriculoperitoneal shunt (VPS) is widely used in the treatment of hydrocephalus (HC), but it is frequently associated with complications such as migration and obstruction of the distal catheter, which can impact therapeutic success. Inadequate fixation of the catheter is one of the primary causes of these complications. Laparoscopic techniques involving fixation of the catheter at two points have been proposed to reduce the risk of migration and improve outcomes, although the literature still lacks consensus on the ideal technique.

Methods: An 80-year-old obese female presented with ataxia, headache, urinary incontinence, and papilledema. HC was confirmed by computed tomography. The patient underwent a right VPS using an innovative laparoscopic technique for distal catheter fixation. After the placement of the ventricular catheter and programmable valve, the distal catheter was secured with two 2-0 polypropylene sutures and two loops in the right paracolic gutter.

Results: The patient progressed well, with no complications in the immediate postoperative period. The fixation was effective in preventing distal catheter migration and reducing obstruction. The laparoscopic approach was successful.

Conclusion: Laparoscopic fixation of the distal catheter with two sutures and loops is a promising technique to improve VPS outcomes, reducing complications. However, further studies are needed to confirm its long-term efficacy and safety.

Keywords: Catheters, Cerebrospinal fluid shunts, Ventriculoperitoneal shunt

INTRODUCTION

The ventricularperitoneal shunt (VPS) procedure is one of the most frequently performed neurosurgical interventions in the treatment of hydrocephalus (HC), responsible for redirecting cerebrospinal fluid (CSF) from the ventricular system to the abdominal cavity.[9] The VPS system consists of a proximal catheter inserted into the ventricular cavity, connected to a subgaleal valve that regulates CSF drainage. This valve is then connected to a distal catheter that extends from the cranial region, traverses the chest under the subcutaneous tissue, and reaches the peritoneal cavity, where the CSF is absorbed.[8]

Despite its benefits, VPS is associated with a range of adverse outcomes, particularly those involving the distal catheter. It is estimated that approximately 60% of patients with a VPS will require revisions during their lifetime, with the most prevalent issues including obstruction, migration, and protrusion of the distal catheter.[5,7,14,16] Aiming to achieve better outcomes, some techniques have been proposed over the years for the insertion of the distal catheter, including open laparotomy, mini-laparotomy, and laparoscopy.[13]

Traditionally, open laparotomy was considered the standard approach however, its high rate of postoperative complications, such as infections, hernias, and abdominal adhesions, has driven the search for minimally invasive techniques.[10] Mini-laparotomy, although offering some advantages, does not ensure the necessary precision for the ideal placement of the VPS catheter. [6] In contrast, laparoscopy provides several benefits, including direct visualization of the abdominal cavity, which allows for the assessment of adequate CSF drainage, the performance of adhesiolysis, the confirmation of the correct positioning of the peritoneal end of the shunt, the prevention of twisting and formation of adhesion pockets, and is particularly beneficial for obese patients. Thus, it has become one of the main access techniques currently chosen.[13]

In this context, there is a description of the use of up to four ports for the laparoscopic placement of the abdominal portion.[3] A successful single-port technique has also been described, though it has been applied to only five patients, with no standardized studies and limited reports on patient characteristics.[6]

Although distal catheter fixation remains a relatively underexplored topic, recent studies suggest that fixation at two distinct points may reduce the incidence of complications, particularly those related to catheter displacement and abdominal obstruction. Additional fixation appears to be an effective strategy for minimizing the risk of migration, a common issue associated with this approach.[19] However, the literature on the ideal fixation techniques and laparoscopic catheter placement methods is still limited, highlighting the need for further studies.

In this case report, we present a female patient with HC who underwent a laparoscopically assisted VPS with three portals, a technique that provides adequate visualization.[3] Distal shunt fixation was performed to reduce the risks of obstruction and catheter migration using an innovative fixation technique, given the lack of consensus regarding the ideal approach. This report aims to contribute to the understanding of the advantages of this technique in the clinical context.

A female patient, 80 years old, obese, with a history of partial meningioma resection at the foramen magnum in 2022, presented to the hospital with symptoms of ataxia, headache, and urinary incontinence. On clinical examination, papilledema was noted, and she scored 8 on the Glasgow Coma Scale scores. The diagnosis of HC was confirmed by computed tomography, as shown in Figure 1.

Given the clinical presentation, the decision was made to proceed with the placement of the right VPS, utilizing an innovative technique for distal catheter fixation. Following the placement of the ventricular catheter, as illustrated in Figure 2, and the installation of the programmable valve, which allows noninvasive regulation of intraventricular pressure and features a siphon mechanism to ensure the pressure remains within a normal physiological range, regardless of the patient's position or CSF flow requirements, the distal catheter was then inserted and secured with two sutures and two loops in the right paracolic gutter.

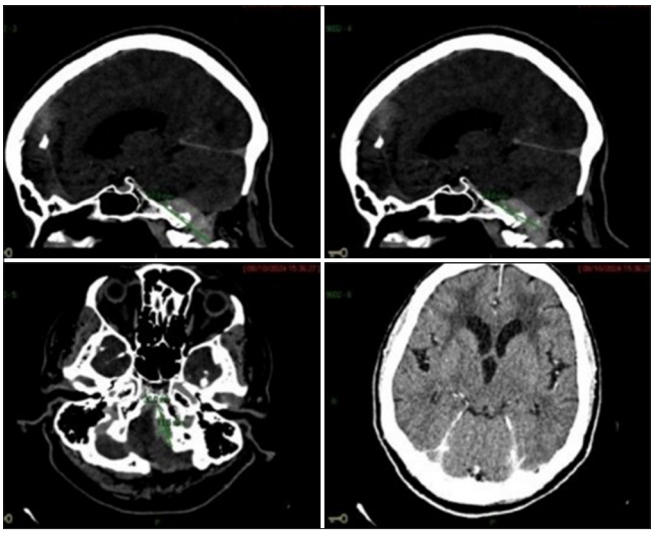

Figure 1: Diagnostic computed tomography study demonstrating dilated ventricles.

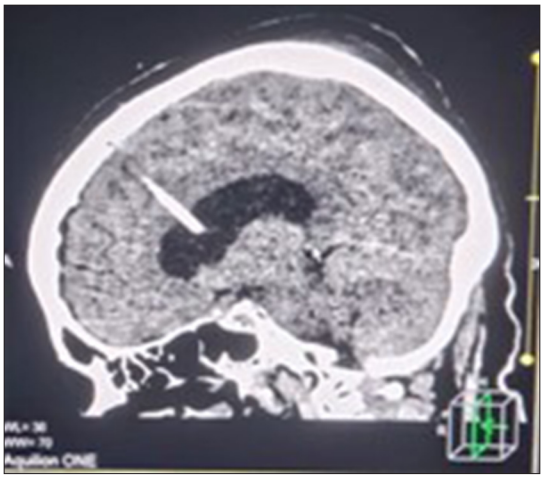

Figure 2: Final control computed tomography scan, with the ventricular catheter in the proper position.

Technique

The procedure was performed using a laparoscopic technique, with three trocar ports (10 mm, 11 mm, and 5 mm), following the procedure of pneumoperitoneum, maintained at a pressure of less than 10 mmHg using a Veress needle. The abdominal cavity was subsequently explored, revealing no adhesions or other pathological findings.

The ventriculoperitoneal catheter was inserted under direct visualization through a subxiphoid incision just below the round ligament. It was then positioned in the right hypochondrium and right paracolic gutter. The procedure continued with the fixation of the catheter to the paracolic gutter using 2-0 polypropylene peritoneal-to-peritoneal sutures without complete immobilization of the catheter. In addition, a 2-0 polypropylene suture was placed at the catheter entry site in the subxiphoid region to anchor it to the peritoneum, as shown in Figures 3-5.

In this approach, the catheter is fixed in such a way that there is no direct fixation of the catheter itself, but rather to the peritoneum in the region of the right paracolic gutter, creating a kind of functional "channel" or "passage." This channel allows the catheter to slide freely, facilitating the drainage of CSF into the pelvic region while preventing twisting or unwanted displacements. In this manner, the catheter remains securely fixed in place while allowing controlled mobility. This mechanism minimizes the risk of complications such as obstruction or displacement, ensures continuous and efficient CSF flow, and guarantees the proper functioning of the drainage system.

After the fixation was completed, hemostasis was confirmed, and the abdominal cavity was cleaned with dry gauze. The trocar ports were closed in layers, and an occlusive dressing was applied.

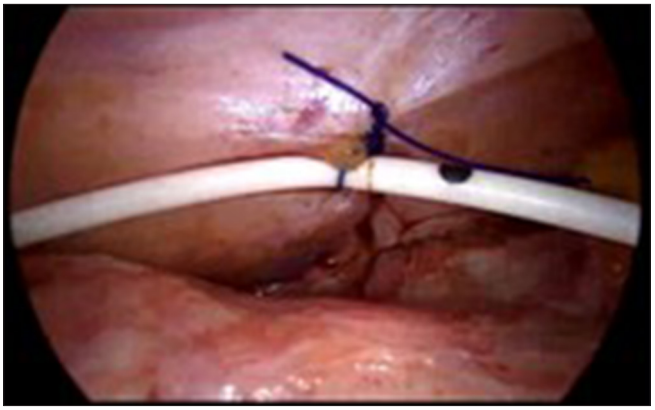

Figure 3: Distal catheter fixed to the peritoneum.

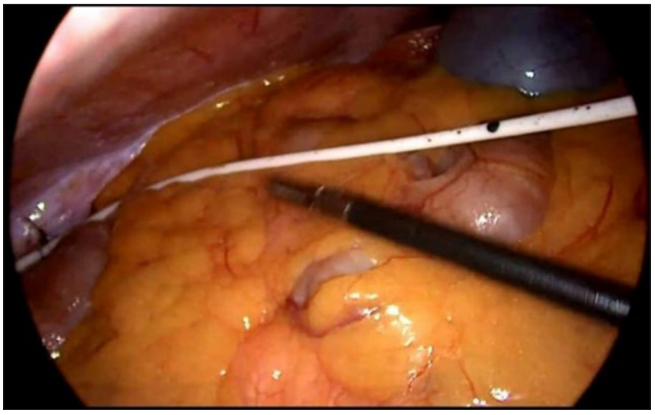

Figure 4: A detailed view of the catheter's path and its fixation to the peritoneum in the right paracolic gutter.

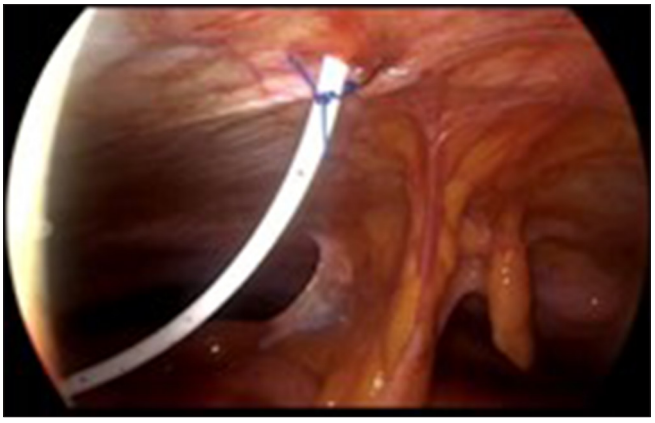

Figure 5: Catheter fixed to the peritoneum in the subxiphoid region.

DISCUSSION

VPS is a widely utilized neurosurgical intervention for the treatment of HC. However, complications may arise, affecting both therapeutic success and patient safety. Among the most prevalent complications are obstructive and abdominal issues, including abdominal pseudocysts, distal catheter migration, inguinal hernia, Grynfeltt's hernia, catheter disconnection, and intestinal obstruction. These abdominal issues can lead to severe outcomes, such as failure of the shunt system, intracranial infections, and, in more severe cases, patient mortality. Effective management of these conditions is essential not only to ensure the continuity of treatment but also to maintain the integrity of the shunt system and to prevent the deterioration of the patient's clinical status.[5,14,19]

In the context of improving VPS outcomes, recent studies indicate that laparoscopically-assisted VPS with distal catheter fixation at two points results in a substantial improvement in shunt survival rates at 12 months. This approach has also proven effective in preventing distal catheter displacement and reducing the need for revision surgeries.[4,7] The distal catheter fixation has shown greater efficacy when compared to open VPS and laparoscopically-based VPS without distal fixation, particularly in patients

with a history of abdominal surgery or previous revision surgeries. Data also suggest that proper catheter fixation with two points helps reduce distal catheter obstruction and prevents shunt occlusion by the omentum.[19]

Moreover, the choice of technique for fixation of the peritoneal end plays a critical role in the procedure's outcomes. Ding *et al*. suggest three fixation methods in suprahepatic space: suture and ligature, titanium clip fixation, and subcutaneous fixation, each with potentially unfavorable outcomes. Subcutaneous fixation, for example, is associated with the risk of pulmonary or pleural damage, while titanium clip fixation may not provide adequate anchorage, leading to catheter displacement and possible obstruction by the omentum. The suture and ligature method is associated with some of the longest average surgical times among the three, leading to the conclusion that there is still a need to identify a more effective technique.[4]

Another described fixation approach is the "falciform technique," in which the distal catheter is fixed to the falciform ligament in the supra-hepatic space. However, a significant concern with this method is that the falciform ligament needs to be punctured, which inevitably causes damage to this tissue and may impair its function. In addition, reports suggest that this technique may involve a vascular area, increasing the risk of complications.[12,15]

The technique we describe positions the catheter in such a way as to direct it toward the pelvis, aligning it with the movement of abdominal fluids, which may facilitate more efficient drainage. In addition, obstructions caused by the omentum and intestines can be avoided, as the shunt's end is located in the right paracolic gutter, a peritoneal compartment between the lateral abdominal wall and the ascending colon, distant from the peritoneal fold and small intestine.[17] The suture in the paracolic gutter creates a channel for the catheter, allowing it to slide, which is beneficial, once catheter rigidity has been associated with device migration. Procedures involving more flexible and soft catheters are less frequently related to this issue. Sridhar *et al*. suggest that protrusion of the catheter into the abdominal wall may occur due to constant contact of the tip with the inner abdominal wall, leading to perforation by the shunt.[18] Rigid-tipped catheters have also been described as causing intestinal perforation.[11]

The sliding of the catheter, in turn, could help avoid migration into the colon or extrusion through the abdominal wall, reducing impact pressure between the distal tip of the catheter and these structures. Furthermore, it has been observed that when the distal end of the catheter adheres to an organ or internal surface, it triggers an inflammatory response that leads to gradual protrusion of the shunt.[1,2]

In this context, the present case report supports the benefits of laparoscopic VPS with distal fixation, emphasizing not only the importance of catheter fixation but also the technique employed. In this case, fixation with two points and two loops in the right paracolic gutter was successful. A more detailed exploration of distal fixation techniques is still needed, as the ideal method for catheter fixation has not yet been definitively established in the literature, highlighting the need for further studies to define more effective and safer practices. Therefore, a careful approach that considers various factors, techniques, and nuances during VPS placement may be crucial for minimizing complications associated with the procedure.

CONCLUSION

We emphasize that, in this report, we describe a surgical technique for the distal fixation of the catheter in the VPS, which involves securing and positioning the distal catheter with two sutures and two loops in the right paracolic fossa. This approach has proven to be effective and appropriate, with the potential to enhance procedural safety and reduce the risk of complications.

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