



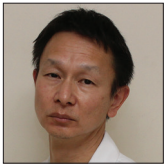
Image Report

Migration of the ventriculoperitoneal shunt into the thoracic cavity: A case report and pitfalls of the rib structure

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Received: 01 August 2023

Accepted: 30 August 2023

Published: 15 September 2023

DOI

10.25259/SNI_645_2023

Quick Response Code:



ABSTRACT

Background: Although ventriculoperitoneal shunting (VPS) is a universal treatment for hydrocephalus, it is generally well-known that the procedure often has complications. Shunt catheter migration is one such complication, but no reports of migration into the thoracic cavity are associated with the surgical technique. Herein, I present a case of thoracic cavity migration of a shunt catheter alongside anatomical pitfalls of the rib structure.

Case Description: The patient was a 62-year-old male diagnosed with subarachnoid hemorrhage due to craniocervical junction arteriovenous fistula and underwent direct surgery to occlude the fistula. We performed VPS for secondary hydrocephalus 1 month later. During VPS, the peritoneal catheter was tunneled subcutaneously over the clavicle to pass from the head to the abdomen. Several months later, the peritoneal catheter had migrated from the peritoneal cavity to the thoracic cavity. A computed tomography scan showed that the peritoneal catheter tunneled subcutaneously over the clavicle, penetrated the thoracic wall through the intercostal space between ribs 1 and 2, and entered the thoracic cavity.

Conclusion: When performing VPS, it is not enough to send the passer through the skin over the clavicle; it must also be tunneled subcutaneously over the ribs while confirming the position of the tip by touch.

Keywords: Abdominal catheter, Hydrocephalus, Peritoneal cavity, Thoracic cavity, Ventriculoperitoneal shunting

INTRODUCTION

Ventriculoperitoneal shunting (VPS) is a universal treatment for hydrocephalus. Although it is a relatively simple surgery, the overall rate of complications is high, with 33th of patients experiencing some form of complication after shunt placement and 2.7% of these cases leading to death.^[2,3]

The most common surgical technique for VPS is to tunnel a shunt passer beneath the skin and, then, send the abdominal catheter through the passer from the head to the peritoneal cavity. The surgeon must ensure that the passer does not enter the thoracic cavity when tunneling from the head incision to the abdominal incision to prevent a complication of pneumothorax.

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It is taught that the clavicle is the structure around which the most care must be taken when subcutaneously moving from the neck to the thoracic wall. If one avoids entering the thoracic cavity by tunneling the passer through the skin over the clavicle, it is often possible to tunnel the catheter subcutaneously over the ribs afterward without difficulty.

I experienced a case in which, despite passing over the clavicle, the catheter passed through the thoracic cavity on the way to the peritoneal cavity, allowing the catheter tip to migrate to the thoracic cavity from the peritoneal cavity. Herein, I present the details of this case along with the anatomical features of the rib structure.

CASE DESCRIPTION

A 62-year-old male with a history of colorectal cancer surgery and hyperlipidemia presented to our hospital with sudden-onset pain in the back of the neck. On arrival, the patient's Glasgow Coma Scale was E3V5M6, with no focal neurologic deficits.

Based on imaging tests, the patient was diagnosed with subarachnoid hemorrhage due to a craniocervical junction

arteriovenous fistula and underwent direct surgery to occlude the fistula. VPS was performed 1 month later because the patient developed secondary hydrocephalus. The postoperative abdominal X-ray confirmed that the shunt catheter was placed in the peritoneal cavity [Figure 1a]. The symptoms of hydrocephalus improved and the patient was discharged to his home through the rehabilitation hospital.

Six months after VPS, an abdominal computed tomography was performed as a follow-up of colorectal cancer surgery and showed that the peritoneal catheter had migrated to the thoracic cavity [Figures 1b and c]. The patient did not experience subjective symptoms, but a small amount of pleural effusion was observed [Figure 1c]. A 3D image of the preoperative shunt catheter and bone structure was created. It was confirmed that the shunt catheter had passed over the clavicle before penetrating the thoracic wall through the intercostal space between ribs 1 and 2 and entering the thoracic cavity [Figures 1d and e]. Because the shunt catheter had passed through the thoracic cavity when inserted into the peritoneal cavity during the initial surgical procedure, it probably migrated to the thoracic cavity due to spontaneous withdrawal.

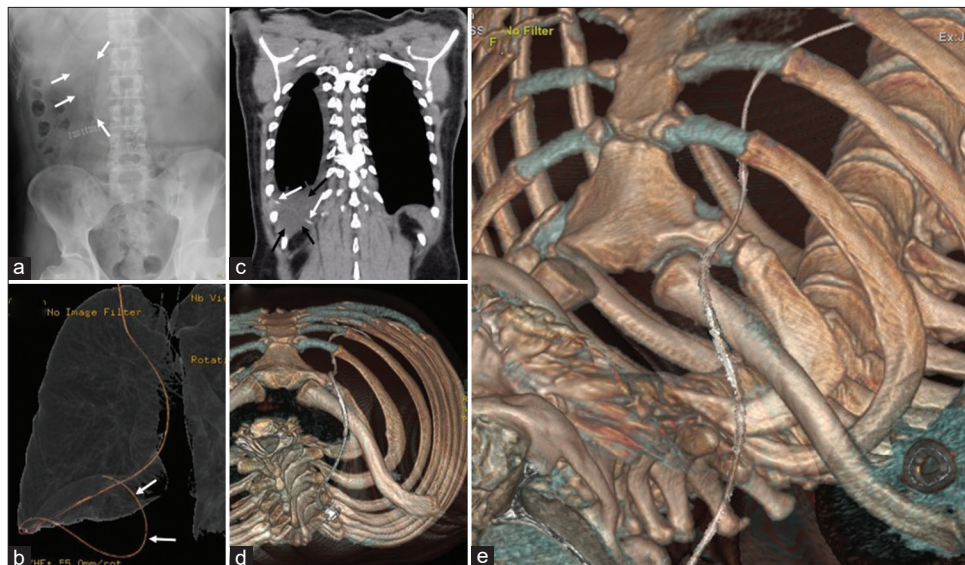


Figure 1: Perioperative imaging findings. (a) Abdominal X-ray, taken on ventriculoperitoneal shunting postoperative day 1, showing a peritoneal catheter (white arrows) placed within the peritoneal cavity. (b) Computed tomography (CT), taken before shunt reconstruction, volume rendering of the pulmonary structure, showing the migration of the peritoneal catheter (white arrows) into the thoracic cavity. (c) Coronal chest CT image, taken before shunt reconstruction, showing pleural effusion (black arrows) around the peritoneal catheter (white arrows) in the thoracic cavity. (d and e) Volume rendering CT of the bone, cranial axial plane image and operative view, showing the peritoneal catheter entering the thoracic cavity through the intercostal space between ribs 1 and 2 despite passing over the clavicle. Note that there is a risk of mistakenly inserting the peritoneal catheter into the thoracic cavity due to the wide intercostal space between ribs 1 and 2, and ribs 2 and 3.

The presence of pleural effusion and associated atelectasis led us to perform reconstructive surgery. We secured the peritoneal catheter, which had migrated to the thoracic cavity, 1 cm caudal to the clavicle. We removed the peritoneal catheter which entered the thoracic cavity without resistance. After removal, we tunneled the peritoneal catheter subcutaneously over the ribs. We, then, reopened the abdominal incision from the previous surgery, opened the anterior/posterior sheath of the rectus abdominis and peritoneum, and verified the intestinal tract within the peritoneal cavity before placing the catheter.

DISCUSSION

In this case, the peritoneal catheter was tunneled through the thoracic cavity while performing VPS. Since the catheter entered the abdomen subcutaneously after passing through the wall side of the pleura (without passing through the diaphragm), it was placed within the peritoneal cavity using ordinary abdominal manipulation. However, as time passed, the peritoneal catheter withdrew from the peritoneal cavity and entered the thoracic cavity, causing pleural effusion and atelectasis, leading to reconstructive surgery.

This case showed that even when the shunt catheter is tunneled subcutaneously over the clavicle, it can pass under the rib caudal to the clavicle, in other words, through the thoracic cavity, on its way to the peritoneal cavity. This is possible due to the anatomical structure of the thoracic wall. Figure 1d (axial plane <perpendicular cross-section [craniocaudal]>) shows the latent risk of mistakenly passing the peritoneal catheter through the intercostal space between rib 1 and rib 2 or rib 2 and rib 3 when tunneling the length from head to abdomen. Furthermore, rib 1 and rib 2 are anatomically different from other ribs in that the external surface is nearly horizontal; while the external surface of ribs 4 and below is nearly vertical, which may also be a factor in the tunnel to the thoracic cavity. To reduce this type of complication, it is not enough for the surgeon to send the passer through the skin over the clavicle, but it is also important to subcutaneously tunnel over the ribs while confirming the position of the tip by touch. Besides, tunneling from the abdominal incision to the cranial incision may be safer than tunneling from the incision on the head to the one on the abdomen.

Furthermore, this case showed that it is possible for a peritoneal catheter that passes through the thoracic cavity on its way to the peritoneal cavity to withdraw into the thoracic cavity over time. The thoracic cavity is in a constant state of negative pressure, while the peritoneal cavity is in a constant state of positive pressure. The difference in pressure may have resulted in the migration

of the peritoneal catheter to the thoracic cavity after placement.

To the best of my knowledge, there is a reported case of peritoneal catheter migration from the thoracic cavity to the peritoneal cavity after VPS in which the catheter passed through the anatomically vulnerable area where the superior epigastric vessels penetrate the diaphragm.^[1] The vulnerability of the diaphragm may also be involved in my case; however, because no perforation site was investigated during reconstruction, the relationship between the anatomical features of the diaphragm and migration in this case remains unclear.

CONCLUSION

Surgeons performing VPS must recognize that even when the shunt catheter is tunneled subcutaneously over the clavicle, it may pass under the rib caudal to the clavicle, in other words, through the thoracic cavity, on its way to the peritoneal cavity, and that catheters, which pass through the thoracic cavity on its way to the peritoneal cavity, can withdraw into the thoracic cavity over time.

Ethical approval

All procedures performed in this report were in accordance with the 1964 Helsinki Declaration. However, a series of treatments had been performed after obtaining appropriate written informed consent from the patients. Additional written consent for inclusion in this study was relinquished by the Ethics Committee of our Hospital because of the retrospective and observational nature of the study (Permission number: 583).

Declaration of patient consent

The Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author(s) confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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How to cite this article: Yokoya S. Migration of the ventriculoperitoneal shunt into the thoracic cavity: A case report and pitfalls of the rib structure. *Surg Neurol Int* 2023;14:340.

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