

Case Report

Spontaneous migration of a peripherally inserted central catheter into the azygos vein and accidental transection during thoracic surgery: A case report

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ABSTRACT

This case report presents an incident of spontaneous migration of a peripherally inserted central catheter (PICC) into the azygos vein, leading to accidental transection during surgery. A patient with esophageal cancer had a PICC placed in the left upper arm one day prior to surgery, with the catheter tip confirmed by intracavitary electrocardiogram (IC-ECG) and anterior/lateral chest X-ray imaging. However, during the surgery, the PICC was unintentionally cut when the surgeon isolated and clamped the azygos vein. The surgical team removed the catheter and re-sutured the azygos vein remnant, introducing avoidable risks. This report analyzes the spontaneous migration of the PICC to the azygos vein and explores possible contributing factors to this incident.

Introduction

Esophageal cancer is a common malignant tumor of the digestive system. In addition to traditional surgical treatments, chemotherapy, and radiation therapy, innovative treatments including multidisciplinary approaches such as neoadjuvant therapy combined with surgical resection¹ have been developed. Regardless of the treatment, establishing vascular access is crucial to patient care. Peripherally inserted central catheters (PICCs) have been widely used in clinical practice to meet the need for medium- and long-term venous infusions in patients undergoing chemotherapy and parenteral nutrition, and in those with poor peripheral intravenous access. The tip of the PICC should ideally be located in the lower third of the superior vena cava (SVC) at the cavoatrial junction, which can be confirmed using chest radiography and intracavitary electrocardiogram (IC-ECG) technology.²

Although PICCs offer many advantages, they are not without complications such as catheter-related thrombosis, infection, and spontaneous migration. Spontaneous migration refers to the displacement of the PICC tip from a satisfactorily documented position in the SVC into adjacent veins several days or months after PICC insertion. This complication is reported to occur in 4% to 12% of cases,³ often resulting

in displacement of the internal jugular vein, ipsilateral subclavian vein, ipsilateral brachiocephalic vein, and azygos vein. Displacement of the azygos vein is extremely rare, usually asymptomatic, and is often not detected until related complications are traced or on imaging, making early recognition challenging.

We report a case of a PICC that spontaneously migrated into the azygos vein and was mistakenly cut during surgery, highlighting the need for clinical vigilance and the importance of improving the clinical quality of care.

Case presentation

A 64-year-old male patient, 176 cm in height, complaining of dysphagia was admitted to the hospital in September 2023. Gastroscopy and subsequent biopsy confirmed esophageal squamous cell carcinoma located 27–35 cm from the incisors, computed tomography (CT) imaging revealed significant thickening across all layers of the mid-section of the esophageal wall, with the tumor positioned near the bilateral tracheo-esophageal groove and enlarged lymph nodes present at the para-vertebral aortic hiatus. Neoadjuvant treatment was devised for this patient after a multidisciplinary consultation. Phase I: Chemotherapy and

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radiotherapy. Phase II: Surgical treatment. A PICC was placed in the patient's right basilic vein during Phase I. However, the patient requested removal of the PICC at the end of Phase I due to physical discomfort.

After the initial treatment phase, the patient was considered eligible for surgery in January 2024. Before surgery, a PowerPICC (polyurethane, 4 Fr, single lumen) was inserted into the patient's left upper limb using a modified Seldinger technique guided by ultrasound. Correct positioning of the PICC tip was confirmed using IC-ECG and anterior and lateral chest radiography (Fig. 1). The patient did not experience nausea, vomiting, or coughing after the catheter placement. However, it is unclear whether any postural changes occur between PICC placement and surgery.

On January 3, the patient underwent cervical-thoracic-abdominal triple-incision radical esophageal cancer surgery at 09:30 am. Catheter function was evaluated with no abnormalities, and fluids were infused via the PICC. The patient was successfully anesthetized before being placed in the left lateral decubitus position, and the procedure was performed as planned. At 11:30 am, the anesthesiologist and nurse observed a halt in the PICC infusion during the surgical step of isolating and clipping the azygos vein. Further examination revealed that the catheter was completely obstructed, and prompt measures were taken to establish alternate access through the peripheral vein to resume infusion. Given the timing of the infusion disruption and clipping of the azygos vein, we suspected that the PICC had been ligated and severed. The PICC nurse was summoned to the operating room. After reviewing the anterior and lateral chest radiograph that had initially confirmed the correct placement of the catheter, it was determined that the PICC had later migrated into the azygos vein and was subsequently ligated and severed during surgery. The ligature was loosened and the catheter segments were removed. By rejoining and inspecting the catheter scale and comparing it with the original insertion length, we confirmed that the entire catheter was fully extracted from the body. Surgery proceeded to the next stage (Fig. 2).

Discussion

Surgery is the primary treatment for locally advanced esophageal cancer, including two-incision radical surgery utilizing a left thoracic approach, and a cervical-thoracic-abdominal three-incision radical esophagectomy via the right thoracic approach. The left thoracic approach presents challenges, such as limited surgical field visibility and restricted maneuvering space, complicating the complete removal of

lymph nodes.⁴ Conversely, the right thoracic three-incision approach optimizes the exposure for surgical access and anatomical alignment, facilitating thorough exposure of the upper mediastinum and enabling comprehensive clearance of the entire mediastinum.⁵ During three-incision radical esophagectomy, the patient was positioned on the left side, which stretched the azygos vein across the esophagus. This positioning necessitated transection of the azygos vein early in the esophageal resection. Unfortunately, in our case, the PICC migrated into the azygos vein and was inadvertently severed when the surgeon isolated and clipped the veins. Reviewing this incident, we unanimously believe that when the surgery proceeds to the step of dissecting the azygos vein, a clamp test should be performed to check for catheter migration into the azygos vein before dissection. Similarly, in addition to radical esophageal cancer surgery, many other surgeries, such as those for breast cancer and head and neck tumors, should be aware of the risk of ligature disconnection or inadvertent suturing when the surgery is performed in the area of the central venous catheter's (CVCs) normal or abnormal travel paths.

Before catheter placement, we evaluated the potential impact of the implantable port of venous access (PORT) and CVC location on the surgical site, and the possibility of a hematoma affecting the anatomical layers. According to the 2021 Infusion Therapy Standards of Practice,⁶ puncturing vessels with a history of injury, thrombosis, or surgery is not recommended. Thus, in this case, a left-sided PICC was selected as the primary choice for the intravenous fluid. Although several studies have suggested that left-sided PICC placement significantly increases the risk of migration into the azygos vein,⁷⁻⁹ right-sided placement does not eliminate this risk, as reported in a report.¹⁰ Therefore, when it becomes unavoidable to opt for left-sided catheterization, assessing the patency and tip position of the catheter via chest radiography is critical before treatment.

In a retrospective study, Haygood et al.⁹ observed 11 instances of catheter migration among catheters placed on the left side, with four initially migrating to the azygos vein. Despite repositioning into the SVC, their migration to the azygos vein recurred during the retention period. This suggests that an initial misplacement, even if promptly corrected, may predispose patients to subsequent spontaneous migration. During catheterization, the P-wave morphology on the IC-ECG was used to confirm the location of the catheter tip. Locating the optimal P-wave can be challenging because of factors such as kinking and migration, which often require multiple adjustments. It is unclear whether our patient experienced

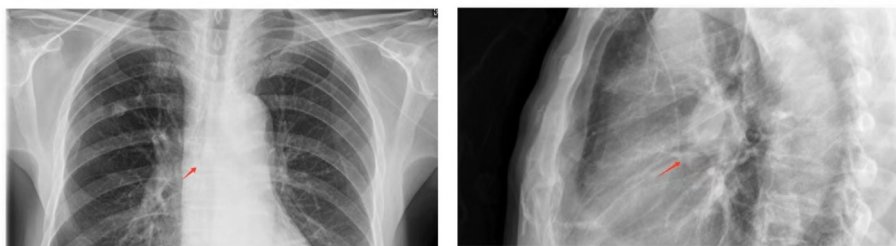


Fig. 1. Anterior/lateral chest X-ray showing the tip of the catheter was correctly positioned in the superior vena cava (SVC).

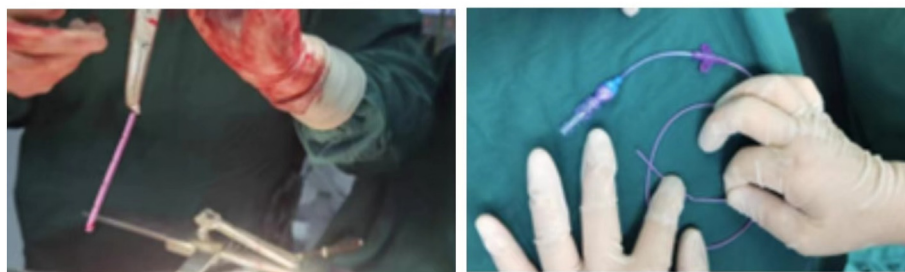


Fig. 2. Catheter removal was verified by comparing its length to the insertion length after rejoining segments.

transient migration that spontaneously corrected and was unnoticed during placement; however, this reminds us that if catheter delivery is challenging or no characteristic P-waves are observed, it is important to analyze and determine the cause instead of forcefully pushing the catheter.

The phenomenon of indwelling catheter migration remains a significant concern, particularly in patients undergoing thoracic surgeries such as those for esophageal cancer.¹¹ Zhang⁷ reported three cases of catheter migration to the azygous vein during surgery for esophageal cancer, which may have been caused by changes in chest pressure and traction that occurred during surgery. During thoracic surgery, our hospital employs either VCV or PCV-VG mode to alter the negative pressure state within the thoracic cavity, ultimately resulting in positive pressure. In addition, the right recurrent laryngeal nerve was dissected, and the separation of the azygos vein may have resulted in mild traction of the SVC during the procedure. Therefore, we suspect that changes in pressure within the thoracic cavity and traction may have caused the patient's migration to the PICC. Certainly, it is not just the surgical procedure that can change thoracic pressure; many factors such as chemotherapy-induced nausea and vomiting (CINV), cough caused by immune-related pneumonitis (IRP), and constipation can affect thoracic and abdominal pressure in patients in medical oncology. This requires prompt identification of such factors in clinical practice, taking intervention measures as soon as possible, and reducing the risk of catheter migration.

Abduction and adduction of the arm may cause movement of the catheter tip.¹² In this case, the patient was first placed in a supine position with the left arm abducted at 90° to undergo arterial cannulation. After successful anesthesia, the patient's left arm was kept still and the patient was adjusted to the left lateral position according to the pathway in the chest. Therefore, it is reasonable to suspect that the surgical position may have caused the tip of the PICC to move upward toward the apex of the SVC. During surgery and throughout the indwelling period of the catheter, various factors related to changes in body position, such as bending over to pick up objects or making significant arm movements, can also lead to catheter migration. Therefore, it is crucial to enhance education regarding catheter-related knowledge and increase the frequency of catheter assessments.

Silicone and polyurethane are currently the most commonly used materials for catheters. According to a report by Zhang et al.,⁷ silicone-based PICCs are extremely soft and can be easily displaced due to forceful flushing or sudden changes in thoracic pressure, leading to the migration of the catheter tip. Our hospital performs over 6000 catheterizations annually using both silicone and polyurethane catheters, inserted by a professional team, and it has not yet been brought to our attention which catheter is more likely to migrate. However, there have certainly been several cases of spontaneous migration of polyurethane into the azygous vein during catheterization, and the catheter inserted in the present patient was also made of polyurethane. Haygood et al.⁶ suggested that deep insertion of a CVC could reduce the displacement of the azygos vein. However, in this case, the patient's catheter was placed using an ultrasound-guided modified Seldinger technique combined with IC-ECG technology, with an insertion length of 47 cm, which indicated that the catheter was located at the 1.5th vertebral body below the prominence, which is a sufficient depth of placement, but still migrated. Neither of these findings is consistent with a previously reported case. Therefore, further studies are needed to fully understand the effects of the catheter material and depth of insertion on spontaneous migration.

Spontaneous migration of a PICC to the azygos vein and mistakenly cut off during thoracic surgery is a low-probability event, but if the dissociated catheter cannot be detected and removed in time, resulting in the catheter being left in the patient's body, it will cause serious damage to the patient. With the widespread use of CVCs in patients with cancer, it is crucial to prioritize the prevention and early detection of spontaneous migration to promote patient safety and minimize complications. By conducting a thorough analysis of this incident, our goal was to offer insight and guidance for clinical practice and collaboration towards preventing future occurrences.

CRediT author contribution statement

Changmin Mao: Writing – Original draft preparation. **Meixiang Wang:** Formal analysis. **Qian Zhao:** Conceptualization, Methodology. **Yuying Shi:** Writing – Revised draft preparation. **Ping Zhu:** Software. **Wenjie Xia:** Formal analysis. **Liuliu Zhang:** Visualization. **Ming Ding:** Conceptualization, Methodology. All authors were granted complete access to all the data in the study, with the corresponding author bearing the final responsibility for the decision to submit for publication. The corresponding author affirms that all listed authors fulfill the authorship criteria and that no others meeting the criteria have been omitted.

Ethics statement

Publication of this case report was approved by the Clinical Research Ethics Committee of Jiangsu Cancer Hospital. The patient has given his written informed consent for this case report to be published.

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Declaration of competing interest

The authors declare no conflict of interest.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

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