Right ventricle migration of a peripherally inserted central catheter: case report and literature review

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ABSTRACT

This study describes a case of fracture and migration of a peripherally inserted central catheter (PICC) identified as an electrode fragment during an endovascular procedure. It analyzes risk factors, mechanisms, and the role of diagnostic imaging for rapid fragment identification. A 65-year-old woman with colon carcinoma had a PICC placed for chemotherapy. Routine chest radiography revealed a linear foreign body near the cardiac silhouette. Computed tomography (CT) confirmed a migrated fragment in the right ventricle. Despite no symptoms, urgent intervention was required due to the intracardiac location. The fragment, identified as a catheter fragment from the PICC, was removed percutaneously using a loop snare system without complications, and the patient was discharged in good condition. Literature indicates that PICC fracture and migration are rare but serious, potentially causing arrhythmias, pulmonary embolism, infections, or valvular damage. Causes include defective materials, mechanical compression (*e.g.*, pinch-off syndrome), improper placement/removal, or material wear. Symptoms vary from none to severe. Early diagnosis relies on radiological surveillance, with chest radiography as the initial step, followed by CT and echocardiography for precise localization. The percutaneous endovascular approach is the preferred treatment due to its efficacy and safety. This case underscores the importance of vigilant radiological follow-up, even in asymptomatic patients, to detect anomalies that could jeopardize safety. CT enabled rapid diagnosis and planning, while the endovascular procedure ensured safe fragment removal and quick recovery. The case highlights the need for healthcare professionals to monitor device integrity and functionality, emphasizing early diagnosis through advanced imaging and prompt intervention to ensure favorable outcomes in complex oncological patients.

Introduction

The peripherally inserted central catheter (PICC) is one of the most common methods of central venous access, particularly useful for patients requiring long-term treatments such as chemotherapy administration, parenteral nutrition, or high-dose antibiotics.[1] The insertion of a PICC is a minimally invasive procedure that offers significant advantages over other types of central venous access, such as central venous catheters (CVC), by reducing the risks of infections

and complications associated with invasive surgery.[2] However, despite its utility, the use of PICCs is not without complications, some of which can be severe, including thrombosis, infection, and, more rarely, catheter fragmentation.[3] Catheter fragmentation is a relatively rare but serious complication that occurs when a portion of the catheter detaches and migrates within the vascular system, posing risks of occluding vital blood vessels and causing pulmonary embolism or other thromboembolic events.[4] This phenomenon can result from multiple factors, including material wear of the catheter, exposure to mechanical forces, or errors during insertion or maintenance of the device.[5] Although fragmentation is uncommon, its incidence has increased with the advent of thinner and more flexible catheters, which, while offering benefits in terms of comfort and reduced infectious complications, are more susceptible to rupture.[6] Diagnosing PICC fragmentation can be challenging, as smaller fragments or those located in difficult-to-reach areas are not always visible with traditional imaging techniques.[7] However, computed tomography (CT) and endovascular ultrasonography have proven useful in identifying and localizing migrated fragments, enabling prompt intervention.[8] Chest radiography, although the initial imaging modality used to monitor PICCs, may not always be sufficiently sensitive to detect small fragments or confirm their precise location.[9] Consequently, early diagnosis requires a combination of diagnostic techniques, including CT, magnetic resonance imaging, and ultrasonography, which offer higher accuracy in localizing fragments.[10] The therapeutic approach to PICC fragmentation depends on the location and size of the fragment, as well as the severity of associated complications. In some cases, if the fragments have not caused significant damage, conservative management with regular patient monitoring may be adopted.[11] However, when fragments migrate into major vessels such as the superior vena cava and cause obstructions or embolisms, more invasive interventions are necessary, which may include surgical removal or the use of endovascular techniques to extract the fragment less invasively.[12] The endovascular approach, employing techniques such as angioplasty or stent placement, is often preferred due to its minimally invasive nature and lower risk of postoperative complications.[13] Prevention of PICC fragmentation primarily focuses on selecting more durable materials and proper catheter management. Catheters made from high-quality materials, such as silicone, offer greater flexibility and resistance to fracture compared to polyethylene catheters.[14] Additionally, adequate training of healthcare personnel and adherence to guidelines during catheter insertion and management can significantly reduce the risks of damage and complications.[15] Patients should be educated about signs and symptoms of complications, such as chest pain or respiratory difficulty, which may indicate catheter blockage or fragment release.[16] Therefore, although rare, PICC fragmentation represents a serious complication that can lead to significant clinical events such as pulmonary embolism or central venous thrombosis. Early diagnosis, prompt intervention, and the implementation of preventive strategies are essential to reduce the incidence of this complication and improve clinical outcomes for patients.[17] The use of more robust materials and proper catheter management are critical for patient safety, while advanced diagnostic techniques and endovascular treatments offer promising options for addressing PICC fragmentation.[18]

Case Report

A 65-year-old woman with a history of left-sided colon carcinoma at stage III underwent left hemicolectomy, followed by adjuvant chemotherapy with the FOLFOX regimen (5-fluorouracil, leucovorin, and oxaliplatin), in accordance with international guidelines. To ensure safe, continuous, and repeated administration of chemotherapeutic agents, a PICC was placed *via* the left basilic vein, with positioning confirmed through intra-procedural fluoroscopy. The procedure was performed smoothly, without immediate or delayed complications related to device insertion. The patient completed all scheduled treatment cycles without significant adverse events or the need for premature catheter removal. After completing therapy, the PICC was removed in an outpatient setting, apparently in full and without documented technical difficulties. During follow-up, several weeks later, the patient reported no significant symptoms, particularly no chest pain, dyspnea, palpitations, or signs of infection. However, a routine chest radiograph revealed a hazy, linear opacity projected near the cardiac silhouette, raising suspicion of an intravascular foreign body. The radiological finding prompted clinical suspicion of a possible residual catheter fragment not detected at the time of removal. To clarify the nature and location of the foreign body, a contrast-enhanced chest CT scan was performed, confirming the presence of an approximately 6 cm linear fragment located within the right ventricular cavity, near the apical trabeculation, with no evidence of perforation, pericardial effusion, or associated thrombosis. Despite its intracardiac position, the patient remained completely asymptomatic, with stable vital parameters, normal laboratory tests, and no signs of systemic infection or embolism. Considering the potential risk of delayed complications, such as arrhythmias, distal embolization, or infection of the fragment, a multidisciplinary management approach was initiated, involving interventional radiology, cardiology, and vascular surgery teams. An endovascular percutaneous procedure was scheduled to remove the fragment using a capture system (loop snare) *via* right femoral venous access. The procedure was successfully performed without complications. The patient experienced an uneventful post-procedure course, with complete resolution of the issue and discharge in good general condition (Figure 1).

Discussion

PICC represents one of the most effective solutions for the treatment of patients requiring long-term central venous access without the need for invasive surgical procedures.[19] PICCs are commonly used in clinical settings where central venous access is necessary, such as for the infusion of chemotherapy, long-term antibiotic therapy, and parenteral nutrition.[20] Their versatility makes them a popular choice; however, they are not without complications and disadvantages, which must be carefully evaluated by the medical team.[21]

The main advantage of the PICC over other types of central venous access devices, such as CVCs, lies in its ease of insertion and the reduced risk of complications associated with invasive surgical procedures.[22] The PICC is inserted *via* a peripheral vein, usually in the forearm, and advanced to the

superior vena cava.[23] This percutaneous insertion method significantly reduces the risk of bleeding and infection compared to surgical placement of a CVC, which involves a more invasive procedure.[24] Moreover, the PICC can be inserted relatively quickly, even at the patient's bedside, with a lower complication rate compared to other central catheters.[25]

Another key benefit of the PICC is its potential for long-term use.[26] This makes it particularly suitable for oncology patients undergoing prolonged chemotherapy cycles, or for those requiring chronic antibiotic therapy.[27] Indeed, numerous studies have demonstrated that the use of PICCs in oncology patients and those with chronic infectious diseases reduces the number of venous punctures and the risk of central venous thrombosis compared to other central devices.[28,29]

However, prolonged use of the PICC is also associated with specific complications, including infection, occlusion, venous thrombosis, and, more rarely, catheter fragmentation.[30] Infectious complications are among the main disadvantages associated with PICC use.[31] Although infection rates are relatively lower than with CVCs, the risk of local and systemic infections remains, particularly in immunocompromised patients.[32] Infections may arise from contamination during catheter insertion, improper handling of the device, or poor maintenance of the insertion site.[33] PICC-related infections can lead to sepsis, a condition that significantly increases patient morbidity and mortality.[34]

Another associated risk is catheter occlusion.[35] Occlusion may occur due to various causes, including blood clots, drug precipitates, or crystallization of infused solutions.[36] Management of occlusion may require thrombolytic therapy or, in more severe cases, catheter removal.[37]

Venous thrombosis is another significant complication.[38] Patients with a PICC are at risk of thrombus formation, especially when the catheter remains *in situ* for extended periods.[39] PICC-related venous thrombosis can cause pain, swelling, and other clinical manifestations, and may impair blood flow and catheter functionality.[40] To prevent thrombosis, close patient monitoring and the consideration of prophylactic anticoagulation in high-risk individuals are essential.[41] In some cases, venous thrombosis may progress to more severe complications such as pulmonary embolism, a potentially life-threatening condition.[42]

Another serious risk associated with PICCs is catheter fragmentation, which occurs when a portion of the catheter breaks off and remains lodged within the patient's vascular system.[43] Although PICC fragmentation is rare, it is among the most serious complications, as catheter fragments may migrate to vital organs, such as the lungs or heart, and cause

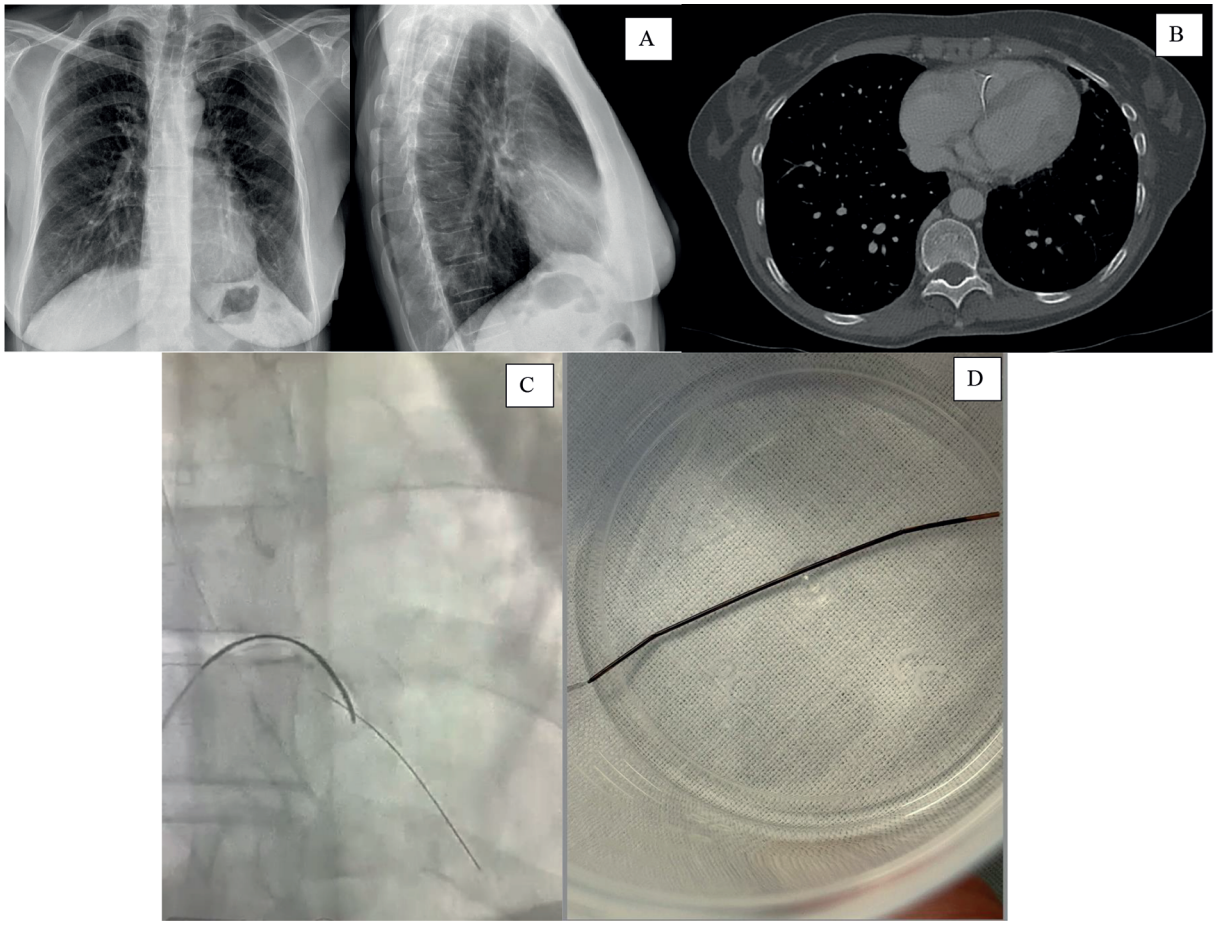

Figure 1. A) A peripherally inserted central catheter with a distal tip located in the right atrium. Thread-like radiopaque image within the cardiac silhouette; B) thread-like hyperdensity within the lumen of the right ventricle; C) venous catheter retrieval performed using a loop snare device; D) electrode fragment removed following endovascular procedure.

severe damage, including embolism, vascular occlusion, or even myocardial infarction.[44] Fragmentation can result from mechanical factors, such as repeated catheter movement, improper insertion techniques, or the presence of infection that weakens the catheter material.[45] The risk of fragmentation is higher in long-term catheters or those subjected to mechanical stress during daily handling.[46]

When fragmentation occurs, immediate management is crucial. One of the first therapeutic measures includes imaging studies, particularly an ultrasound or a CT scan, to locate the detached catheter fragment.[47] Surgical removal is often necessary and may require a specialized intervention, carrying additional risks for the patient.[48] Due to the severity of this complication, patients with a PICC should undergo regular monitoring to verify catheter integrity, and any abnormalities, such as sudden pain or difficulty with infusion, must be promptly investigated.[49] Additionally, patients should be educated about the warning signs of possible catheter fragmentation, such as chest pain or respiratory difficulties, which could indicate embolization of a catheter fragment.[50]

Mechanical complications, such as catheter malpositioning, also represent a significant concern.[51] The PICC must be correctly positioned in the superior vena cava to ensure optimal function.[52] Incorrect placement can compromise the therapeutic efficacy and increase the risk of complications, such as infection or thrombosis.[53] To reduce the risk of malpositioning, catheter placement should be guided and verified through imaging techniques, such as ultrasound or X-ray.[54]

Beyond physical complications, PICC is also associated with psychological considerations for patients.[55] The placement of a PICC may be perceived as invasive, even though it is less traumatic than other central devices.[56] Pain management and patient anxiety during and after insertion are important variables that require attention.[57] Proper evaluation of the patient's tolerability is essential to ensure the PICC can be used without compromising psychological well-being.[58]

It is crucial to highlight the need for adequate training of healthcare professionals managing PICCs.[59] Insufficient training may lead to errors during catheter insertion, maintenance, or removal, increasing the risk of complications.[60] Ongoing education and awareness of best practices in PICC management are essential to improve patient outcomes and reduce complication rates.[61] Therefore, PICC represents a safe and effective option for long-term venous access in various clinical contexts.[62] Although the benefits are numerous, including a lower infection risk and potential for prolonged use, the associated complications, such as infection, occlusion, venous thrombosis, and fragmentation, require careful monitoring and management.[63] Careful patient selection, proper staff training, and continuous monitoring are crucial to ensure successful PICC use and to minimize the risks associated with its application.[64]

Conclusions

In conclusion, the incidental detection of PICC fragments represents a clinical complication that, although rare, poses significant potential risks to patient health, including severe outcomes such as pulmonary embolism, sepsis, or damage to surrounding organs. Prompt and accurate identification of such fragments is crucial to prevent fatal complications and to optimize therapeutic intervention.

In this context, diagnostic imaging emerges as an essential element, with advanced techniques such as chest radiography, ultrasonography, and CT playing a fundamental role in localizing and monitoring the migration of fragments. These non-invasive and highly sensitive diagnostic tools enable precise visualization of fragment position, allowing for timely and effective intervention, which may include surgical removal or other therapeutic maneuvers. The integrated use of imaging technologies also facilitates postoperative monitoring, minimizing the risk of complications and improving the long-term outcome for the patient.

In summary, managing a case of PICC catheter fragmentation requires a multidisciplinary approach, with diagnostic imaging playing a central role in ensuring safe, targeted, and effective treatment.

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