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Case Report

Percutaneous Retrieval of an Embolized Catheter Fragment in Right Heart Chambers in Pinch-Off Syndrome and Subsequent Reimplantation: Nurse's Role in Interventional Cardiology—A Case Report

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Abstract

"Pinch-Off Syndrome," first described by Hinke, is a mechanical complication of totally implantable central venous catheters inserted via subclavian venous access. It occurs when the catheter is compressed between the clavicle and the first rib. Compression can cause transient catheter obstruction and may result in rupture or even complete resection and embolization of the catheter. In this case report, we describe our experience of percutaneous transvenous removal of an embolized port-a-cath fragment within the right heart chambers following a rupture. We used the "retrieval snare" technique and subsequent reimplantation through internal jugular access. The intervention occurred in the same session and involved a multidisciplinary team for a 55-year-old man in need of adjuvant chemotherapy.

Keywords: pinch-off syndrome; catheter fragment; compression

1. Introduction

The Port-a-Cath is a long-term, fully implantable central venous access device (CVAD) designed for extended clinical use, often spanning months or years. The system comprises two primary components: an implanted subcutaneous reservoir (port), typically positioned on the chest wall, and a flexible catheter connected to the reservoir that terminates in a major vein, such as the superior vena cava. Following surgical implantation, the device remains entirely subdermal, with only a palpable elevation visible. Access is achieved using a specialized non-coring needle (Huber needle) to penetrate the reservoir's silicone septum. This allows for the administration of chemotherapy, fluids, parenteral nutrition, and blood sampling, providing a stable and secure access point that minimizes the need for repeated peripheral venipuncture [1]. By preserving the patient's peripheral venous system and reducing the risk of infection compared to externalized catheters, the Port-a-Cath significantly enhances patient comfort and treatment efficacy, facilitating continuity of care in both hospital and home settings. It is particularly indicated for oncological patients requiring long-term infusion of vesicants or irritants that could otherwise damage the vascular intima [1,2]. While central venous catheterization is considered a routine procedure, it is not without risk. Immediate complications may include accidental arterial puncture, pneumothorax, hemothorax, cardiac tamponade, arrhythmias, and embolism.

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Late complications encompass vascular or lymphatic damage, thrombosis, catheter fracture, malposition, catheter line-associated bloodstream infections (CLABSI), and Pinch-off Syndrome (POS) (Figure 1) [3]. First described by Aitken and Minton as a "warning sign" [4] and formally classified by Hinke, POS is a mechanical complication resulting from the compression of a subclavian catheter between the clavicle and the first rib [5]. This persistent compression can cause transient catheter occlusion, structural fatigue, and eventual fracture, potentially leading to catheter resection and subsequent embolization [6]. Although rare, with an estimated incidence of 1.1% to 5%, embolization requires prompt intervention [5–7]. The majority of embolized fragments (93.5%) are successfully retrieved via percutaneous procedures, the gold standard, while only a minority (2.3%) necessitate surgical thoracotomy. Embolized fragments most commonly migrate to the pulmonary artery (35.0%), right atrium (27.6%), right ventricle (22.0%), or the superior vena cava and peripheral veins (15.4%) [8]. The primary advantages of Port-a-Cath implantation include the preservation of venous integrity, simplified drug administration, enhanced integration between hospital and community care, reduced hospitalization duration, and lower infection rates. Furthermore, the absence of external components during treatment intervals grants patients total freedom of movement and significantly improves their overall quality of life.

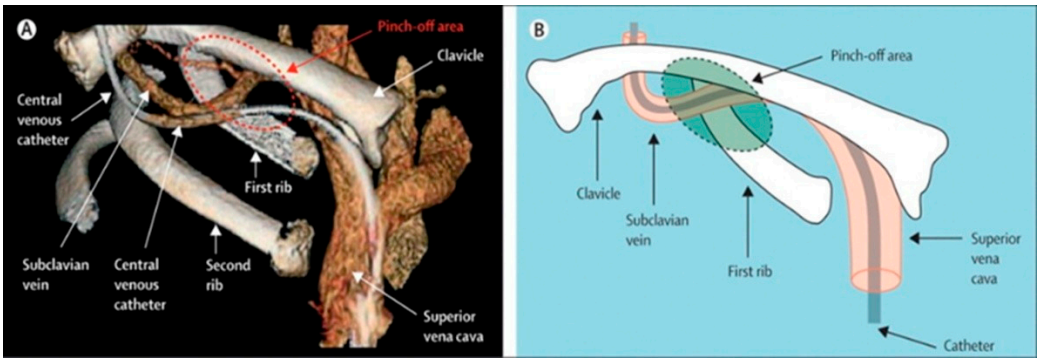

Figure 1. Mechanism of the Pinch-Off Syndrome. (**A**) shows a 3D reconstruction of the mechanical conflict between the clavicle and the first rib; (**B**) schematically illustrates the compression (costoclavicular pinch) of the catheter in the subclavian vein, which causes cyclic stress, obstruction, and potential device fracture.

2. Case Report

A 55-year-old male oncology patient underwent the implantation of a Port-a-Cath for adjuvant chemotherapy; however, two weeks post-implantation, he experienced significant resistance during infusion. This clinical sign was inappropriately managed by repositioning the patient's arm and neck. This maneuver restored flow but masked the underlying mechanical conflict, leading to the omission of a suspected Pinch-off Syndrome (POS). Nursing management of implantable ports requires a synthesis of procedural rigor and advanced clinical reasoning, as any functional abnormality must be interpreted as a critical warning sign [6–10]. In this case, the underestimation of positional dependence and flushing resistance facilitated catheter fatigue and eventual fracture. The following day, the patient presented to the Emergency Department with palpitations, chest pain, and dyspnea. While cardiac biomarkers and electrocardiogram (ECG) results were unremarkable, a chest X-ray and subsequent CT scan (Figure 2A,B) revealed a Grade 3 POS [5] (Table 1), characterized by a complete catheter transection and fragment embolization into the right-sided heart chambers [11].

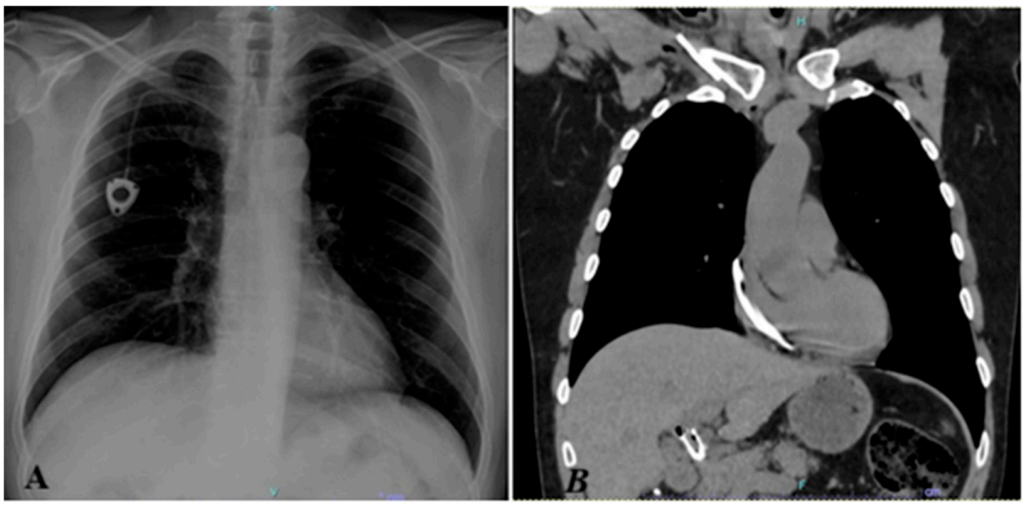

Figure 2. Critical evolution of Pinch-off Syndrome: Port-a-Cath fracture and embolization. The images document the structural failure of a Port-a-Cath system resulting from chronic mechanical stress within the costoclavicular space. Panel (**A**)—Chest X-ray: The radiographic examination reveals the complete disconnection (resection) of the catheter from the Port-a-Cath septum. The embolized fragment is clearly visible, having migrated with the blood flow and lodged within the right-sided heart chambers. This finding corresponds to Grade 3 of the Hinke classification [5], indicating that the bone compression has exceeded the polymer's fatigue strength. Panel (**B**)—CT scan: The coronal reconstruction confirms the position of the radiopaque fragment within the cardiac chambers. The CT scan allows for the assessment of risks such as myocardial perforation, thereby guiding the emergency endovascular retrieval strategy for the detached Port-a-Cath segment.

Table 1. Grading of the Pinch-Off Syndrome [5].

Grade	Severity	Recommended Action
0	No distortion	No action
1	Distortion is present without luminal narrowing	Chest x-rays should be taken every 1–3 months to monitor the pinch-off progression to grade 2 distortion. Shoulder positioning during chest X-rays should be noted, as it can contribute to changes in distortion grades.
2	Distortion is present with luminal narrowing	Removal of the catheter should be considered
3	Catheter transaction	Prompt removal of the catheter

The patient was urgently referred to the Interventional Cardiology Department for percutaneous retrieval and subsequent device reimplantation. The interventional cardiology nurse coordinated the entire care process, executing a rigorous pre-procedural safety checklist that included patient identification, equipment verification, hemodynamic monitoring, and strict adherence to aseptic barrier precautions [12]. During the procedure, the nurse collaborated as a second operator in the emergency endovascular extraction via a right femoral vein approach. Using a 7 French introducer, a pigtail catheter, and a 0.035-inch guide wire, a transvenous snare was deployed to capture and remove the embolized fragment within the right atrium and ventricle under fluoroscopic guidance (Figure 3A,B). Following successful extraction (Figure 4A,B) [3–13], the multidisciplinary team comprising an interventional cardiologist, nurse, technician and anesthetist performed an immediate Port-a-Cath reimplantation via the internal jugular vein to prevent recurrent mechanical compression. Correct intravascular tip positioning was confirmed through intracavitary ECG (monitoring the maximal P-wave amplitude at the atrioventricular junction), fluoroscopy, and blood aspiration. This integrated multidisciplinary approach

allowed the patient to avoid invasive surgical thoracotomy and multiple procedures, emphasizing that specialized nursing training is paramount for the early diagnosis and safe management of catheter-related POS.

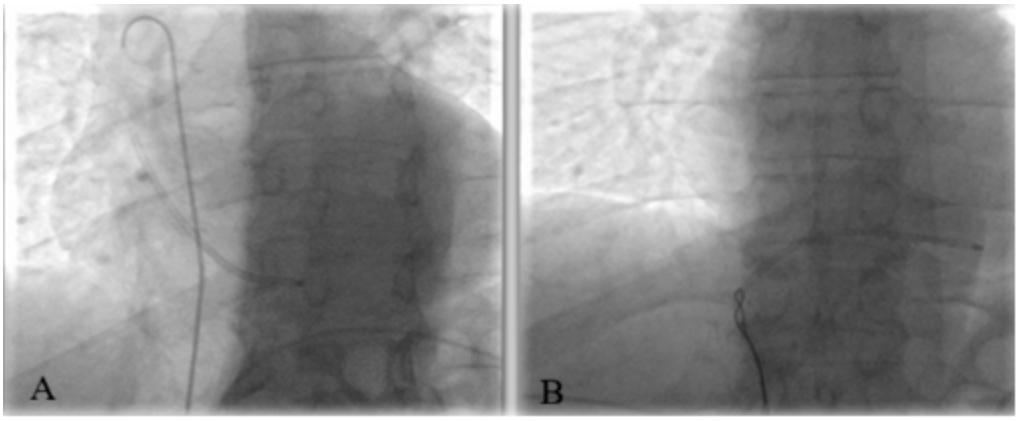

Figure 3. Endovascular retrieval of the embolized Port-a-Cath fragment. The image illustrates the stages of the minimally invasive procedure required to remove the foreign body from the cardiac compartment, avoiding the need for open-heart surgery. (**A**) Under real-time fluoroscopic guidance, a diagnostic catheter (often a Pigtail or similar model) is introduced to reach the ventricular chambers. The goal is to hook the Port-a-Cath fragment and reposition it into a more favorable vascular area for definitive capture. (**B**) The image shows the use of a loop retrieval device (venous loop or snare). The loop is tightened around the catheter fragment, firmly "trapping" it. Once secured, the foreign body is carefully retracted through the venous system until its complete extraction via the access site (usually the femoral vein).

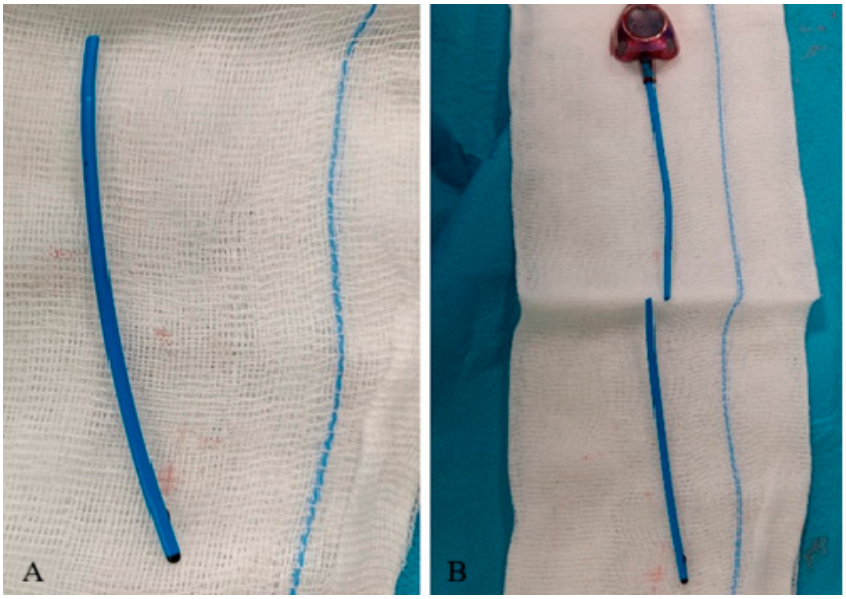

Figure 4. Macroscopic evidence of Port-a-Cath fracture and embolization. (**A**) Embolized Fragment: This image shows the distal segment of the catheter that had migrated into the right-sided heart chambers. While the tip remains intact, the fracture point at the opposite end is sharp. This fragment represents a high-risk foreign body, capable of causing ventricular arrhythmias, endocarditis, or pulmonary embolism until its endovascular retrieval. (**B**) Fractured System: In this overview, the recovered fragment is placed alongside the proximal portion still attached to the port septum. The separation is a direct result of the cyclic stress endured at the compression point between the clavicle and the first rib. The clean break confirms that the polymer was literally "sheared" by the prolonged mechanical action of the bony structures, acting as shears during the patient's shoulder movements.

3. Discussion

Pinch-Off Syndrome (POS) originates from the complex anatomical configuration of the sternocostal and sternoclavicular joints, which can lead to a pathological narrowing of the costoclavicular space [2–5]. This narrowing is frequently exacerbated by postural variations; while catheters are typically inserted with the patient in a supine position, the transition to an upright posture, compounded by the weight of the shoulder, further constricts the space between the clavicle and the first rib. Although catheter fracture due to POS is a rare complication, it consistently affects approximately 1% of patients receiving central venous access devices via the subclavian approach, a statistic that has remained stable since it was first reported 35 years ago. The pathophysiology of POS is exclusive to patients whose catheters are inserted via an infraclavicular approach to the subclavian vein. Several risk factors have been identified, including the inherent flexibility of silicone or polyurethane materials, suboptimal connections between the reservoir and the catheter, and the subcutaneous medial insertion of the device. Medial positioning is particularly hazardous as it subjects the catheter to chronic, repetitive compressive forces and shearing stress [7] within the narrowest portion of the clavicular-costal angle. To mitigate this risk, clinicians should favor a more lateral insertion point along the subclavian vein or, preferably, utilize the internal jugular vein. As noted by Mirza et al., the jugular approach is superior because it eliminates the risk of "crush syndrome," offers easier ultrasound guidance, and is associated with significantly lower rates of fracture and embolization. The clinical presentation of POS is highly variable. While some patients remain asymptomatic, others may present with acute cardiovascular symptoms, including chest pain, palpitations, arrhythmias, or even stroke. Device-specific dysfunction is a common red flag, characterized by localized pain, swelling, resistance to bolus injection, and a paradoxical loss of flow that fluctuates with postural changes. The stakes for early diagnosis are remarkably high: approximately 71% of patients with catheter embolization develop severe complications, such as pulmonary thromboembolism, right heart failure, endocarditis, or death (1.8%). Furthermore, early recognition is vital to prevent the endothelialization of the fragmented catheter. If the fragment becomes incorporated into the vascular wall, percutaneous retrieval becomes significantly more complex [13]. In this context, properly trained nurses with advanced clinical reasoning skills are indispensable. By synthesizing clinical assessment with a deep understanding of pathophysiology and maintaining multidisciplinary communication, nurses ensure patient safety through the timely identification of warning signs. Adopting the objective classification proposed by Hinke is essential for standardized management:

- Grade 0: No narrowing in the catheter's course.
- Grade 1: An abrupt change in direction without luminal narrowing.
- Grade 2: Evident luminal narrowing as the catheter passes beneath the clavicle.
- Grade 3: Complete catheter transection.

As demonstrated in the present case, a Grade 3 [5] classification necessitates immediate endovascular intervention to retrieve the embolized fragment and remove the remaining port components. Currently, percutaneous retrieval via the femoral vein is the gold standard, boasting a high success rate of 97.8% and a low complication rate of 3% [8–13]. However, in cases where percutaneous endovascular retrieval fails—often due to fragment endothelialization, distal migration into small pulmonary branches, or complex knotting—alternative strategies must be considered. Surgical thoracotomy remains the primary rescue intervention [8], particularly when the fragment is positioned across heart valves or poses an immediate risk of cardiac perforation. However, in high-risk surgical candidates or when fragments are lodged in stable, asymptomatic distal positions, a conservative approach with long-term anticoagulation and radiological surveillance may be debated [13]. Nevertheless, the literature warns that leaving a fragment in situ carries a

persistent risk of endocarditis, chronic thrombosis, and late migration [8–13], making a multidisciplinary evaluation mandatory. In this context, properly trained nurses with advanced clinical reasoning skills are indispensable. By synthesizing clinical assessment with a deep understanding of pathophysiology and maintaining multidisciplinary communication, nurses ensure patient safety through the timely identification of warning signs.

4. Conclusions

The early recognition of Pinch-Off Syndrome (POS) is paramount in preventing catastrophic catheter fragmentation and systemic embolization. As a rare but potentially fatal complication, POS necessitates immediate clinical intervention. The percutaneous endovascular approach remains the gold standard for fragment retrieval, yielding excellent clinical outcomes; approximately 93.5% of embolized fragments are successfully removed via this method. Conversely, surgical intervention via thoracotomy is required in only about 2.3% of cases, typically reserved for complex scenarios where endovascular techniques prove insufficient or where direct access to cardiac structures is mandatory. In specific clinical contexts, such as when a fragment is located in a stable, distal peripheral position and the patient presents prohibitive surgical risks, a conservative strategy of leaving the fragment in situ with longitudinal monitoring may be considered, although this carries inherent risks of delayed thrombosis or endocarditis. Unrecognized POS may lead to severe sequelae, including lethal cardiac arrhythmias and septic embolization. To mitigate the risk of mechanical failure, alternative venous access sites, such as the internal jugular or axillary veins, should be prioritized, ideally utilizing ultrasound-guided techniques to ensure safe insertion [2–9]. Most periprocedural and early complications are directly related to the implantation technique; therefore, the incidence of such events can be drastically reduced by standardizing clinical processes and strictly adhering to evidence-based guidelines for central venous catheter (CVC) placement. The integration of real-time ultrasound for venous puncture and fluoroscopic guidance for tip positioning further enhances procedural safety. The favorable resolution of this clinical case underscores the necessity of a multidisciplinary approach and a highly specialized interventional team [9–12]. Seamless collaboration among the interventional cardiologist, specialized nurse, anesthetist, and radiologic technician facilitated a rapid, efficient, and effective response, sparing the patient from the physiological stress of invasive open-chest surgery. Furthermore, advanced nursing training in the management of CVCs is essential; the nurse's role extends beyond intraprocedural assistance to encompass the vigilant monitoring and early diagnostic reasoning required to identify and intercept complications before they escalate.

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