

Case Report

A Case Series of Successful Percutaneous Retrieval of Intra-Arterial Broken Catheter Fragments Using Two Different Techniques

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Highlights

- Successful retrieval of intra-arterial broken catheter fragments using two distinct percutaneous techniques.
- Demonstrates practical balloon-assisted and snare-based retrieval strategies adaptable to varying anatomical challenges.
- Reinforces preventive strategies and decision-making framework for catheter-related hardware complications.

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ABSTRACT

Over the past two decades, technological refinements, the introduction of newer tools, and both physician and patient preference for catheter-based techniques have contributed to a global increase in endovascular interventions. Despite these advancements, operators continue to encounter unforeseen hardware-related complications stemming from various factors. Globally, reports of broken or dislodged fragments of hardware—such as catheters, guidewires, angioplasty balloons, and stents—have become increasingly common. These fragments may result in life-threatening consequences. Accordingly, interventionists must remain vigilant and proficient in various retrieval techniques.

We present two cases involving successful percutaneous retrieval of broken, dislodged, and embolized angiographic catheters from the coronary and renal arteries, each performed using a distinct technique.

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Introduction

As the spectrum and complexity of interventional cardiac procedures continue to expand, diagnostic and guide catheters have become indispensable tools for accessing the heart and vascular tree.

Although less common than other hardware-related complications, fragmentation or embolization of these catheters can occur. Prompt retrieval is essential, as retained fragments may serve as a nidus for thrombus formation or infection if left in situ.

Catheter fragmentation and embolization were first reported in 1954¹, with surgical retrieval remaining the only option until the introduction of percutaneous techniques in 1964.² A report published in 1971 described 29 trans vascular foreign body retrievals, six of which were performed percutaneously.³ Since then, the “percutaneous attempt-first” approach to intravascular hardware retrieval has steadily become standard practice.⁴⁻⁷ This shift has been facilitated by the development of dedicated retrieval devices and improvised techniques.

Catheter fragmentation and embolization are more frequently reported with central venous catheters. Embolization into the right heart and pulmonary tree often signals serious complications and presents a challenge for percutaneous retrieval. Intra-arterial hardware-related events are comparatively rare, with a reported incidence of 0.1% to 0.8% in cases of coronary interventions.⁸ Nonetheless, specific data on catheter fragmentation and embolization remain limited. These events may have serious consequences, as fragments can rapidly embolize with arterial flow and become lodged in coronary, cerebral, renal, or peripheral vessels, potentially leading to ischemic complications if left unattended.

Here, we report two cases of successful percutaneous retrieval of broken, dislodged, and embolized angiographic catheters from the coronary and renal arteries, each performed using a distinct technique.

CASE 1

A 59-year-old woman with diabetes, The patient was monitored for 48 hours for any complications and subsequently underwent

dyslipidemia, and symptomatic severe calcific aortic stenosis underwent coronary angiography as part of preoperative coronary evaluation. Through a 5F femoral introducer sheath, a 5F diagnostic Judkins Left 4 (JL) catheter (Cordis Corp, Miami, Florida) was introduced along with a 0.035 × 260-cm polytetrafluoroethylene (PTFE) J-tip wire (Cordis Corp, Miami, Florida) to the level of the lowermost aortic sinus in the left anterior oblique view. Rapid withdrawal of the PTFE wire into the Judkins catheter while the catheter tip was abutting a heavily calcified aortic valve resulted in transection of the catheter's soft ring tip (Figure 1A). The fragment immediately embolized into the left anterior descending artery (LAD) (Figure 1B).

The diagnostic catheter was immediately and safely exchanged for a 6F Extra Back Up (EBU) 3.5 guiding catheter (Medtronic Inc, Minneapolis, Minnesota) over a 7F femoral introducer sheath. Angiography revealed no significant stenosis in the left coronary artery and showed the ring tip fragment lodged en face with the lumen of the distal LAD. A 0.014×190-cm Fielder FC coronary guidewire (Asahi Intec, Japan) was carefully introduced through the lumen of the ring tip and parked in the distalmost LAD. Extreme caution was exercised to avoid misalignment or displacement of the fragment during this step. A 2.0×9-mm Sprinter noncompliant balloon (Medtronic Inc, Minneapolis, Minnesota) was advanced over the wire across the ring tip and held inflated to 8 atmospheres to anchor the fragment (Figure 1C). Once the fragment was stabilized with a wire and an inflated balloon, a small bolus dose of intracoronary nitroglycerin was administered to facilitate smooth retrieval and prevent coronary vasospasm. The fragment was then slowly and carefully withdrawn to the tip of the guiding catheter. The entire system—with the embolized fragment secured by the inflated balloon at the mouth of the guiding catheter—was cautiously removed under fluoroscopic guidance into the femoral sheath (Figure 1D and Video 1).

Once the ring tip was positioned within the femoral sheath, it was exteriorized by opening the hemostatic valve (Figure 1E). Activated clotting time (ACT) was adjusted and maintained at 350 seconds throughout the procedure. Following successful retrieval, an angiogram was performed to confirm the absence of coronary or access site complications (Figure 1F).

successful aortic valve replacement surgery during the hospital stay.

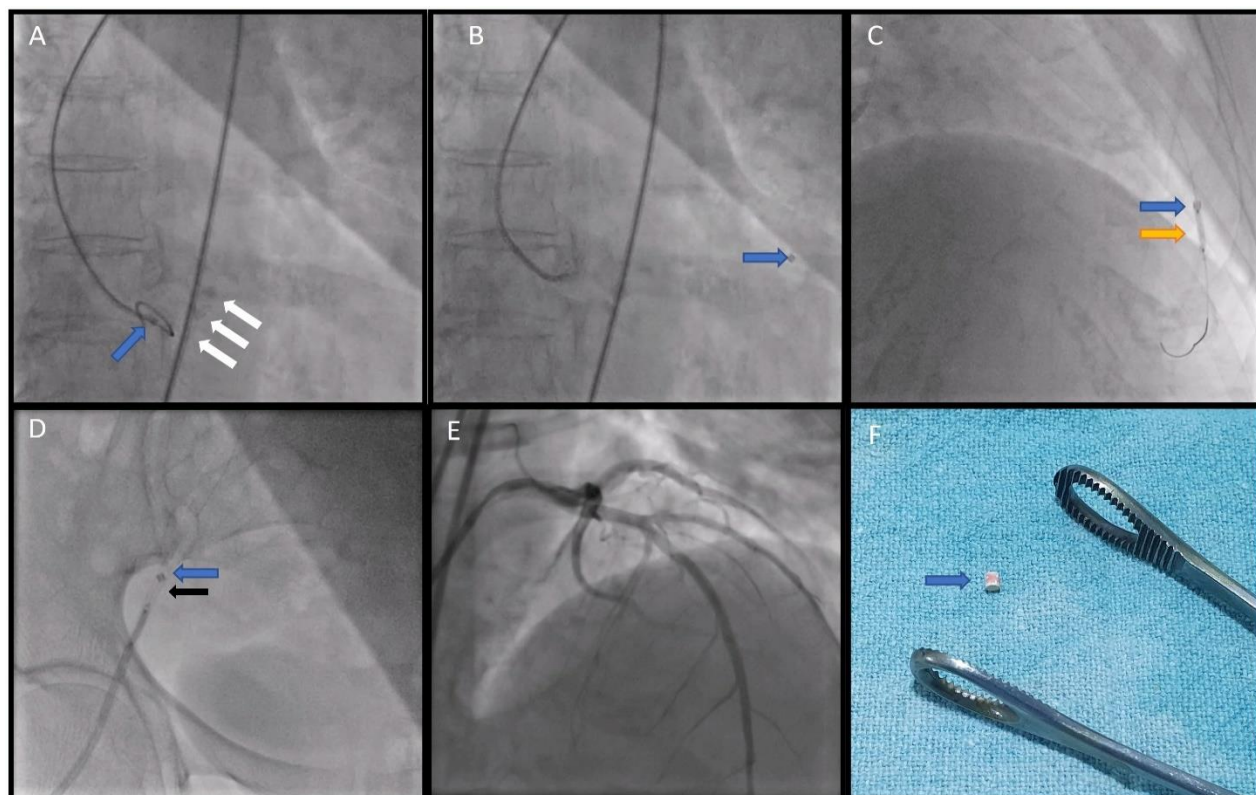


Figure 1. (A–F). Fluoroscopic images of coronary catheter embolization and retrieval of a detached PTFE ring-tip fragment from a JL4 diagnostic catheter.

(A) LAO 40° view showing a 5 Fr JL4 diagnostic catheter with PTFE ring tip wedged against the heavily calcified aortic valve (three white arrows). (B) Fluoroscopic image demonstrating the detached ring-tip fragment of the JL4 diagnostic catheter embolized and lodged in the distal LAD (blue arrow). (C) Embolized ring tip (blue arrow) stabilized by a 0.014" coronary guidewire passed through its lumen and an inflated over-the-wire coronary balloon (yellow arrow). (D) Embolized ring tip (blue arrow) seen in the femoral–iliac segment being retrieved as an assembly using the balloon–wire stabilization technique. (E) Final coronary angiogram of the left coronary artery in RAO cranial view after removal of the catheter fragment, showing preserved LAD flow without dissection, thrombus, or other complications. (F) Ex vivo image after retrieval showing the exteriorized ring-tip fragment of the JL4 diagnostic catheter (blue arrow).

CASE 2

A 52-year-old woman with unstable angina underwent diagnostic coronary angiography via radial access. A 5F JL 3.5 catheter (Cordis Corp, Miami, Florida) was advanced through a 5F introducer sheath. Difficulty entering the ascending aorta, possibly due to the aberrant origin of the right subclavian artery, led to radial artery spasm and repeated vigorous rotation of the catheter. These maneuvers resulted in catheter kinking, and an attempt to relieve it by passing a 0.035 × 260-cm PTFE wire caused fragmentation within the descending aorta. Fluoroscopy revealed probable embolization of the fragment into the abdominal vasculature (Figure 2A).

An 8F, 25-cm introducer sheath (Terumo Medical, Japan) was immediately inserted via the right femoral artery. ACT was adjusted to approximately 350 seconds with additional heparin

doses. Fluoroscopic imaging revealed the fragment lodged in the right renal artery, which was readily engaged using a 7F Judkins Right 4 (JR) guiding catheter. Angiography demonstrated good flow in the renal artery without evidence of thrombus or dissection (Figure 2B). The broken catheter fragment, measuring approximately 8 to 10 cm in length, was positioned horizontally along the long axis of the renal artery. The proximal end of the fragment had a sharp edge, whereas the distal end was circular and smooth.

An Ensnare device (6–10 mm × 120 cm × 100 cm; Merit Medical, Utah, USA) was employed to capture the embolized fragment by its proximal edge and advance it to the tip of the guiding catheter (Figure 2C, D). The entire assembly was then brought into the sheath and exteriorized (Figure 2E, F and Video 2). A post-retrieval angiogram demonstrated normal renal blood flow. The patient remained stable without any complications.

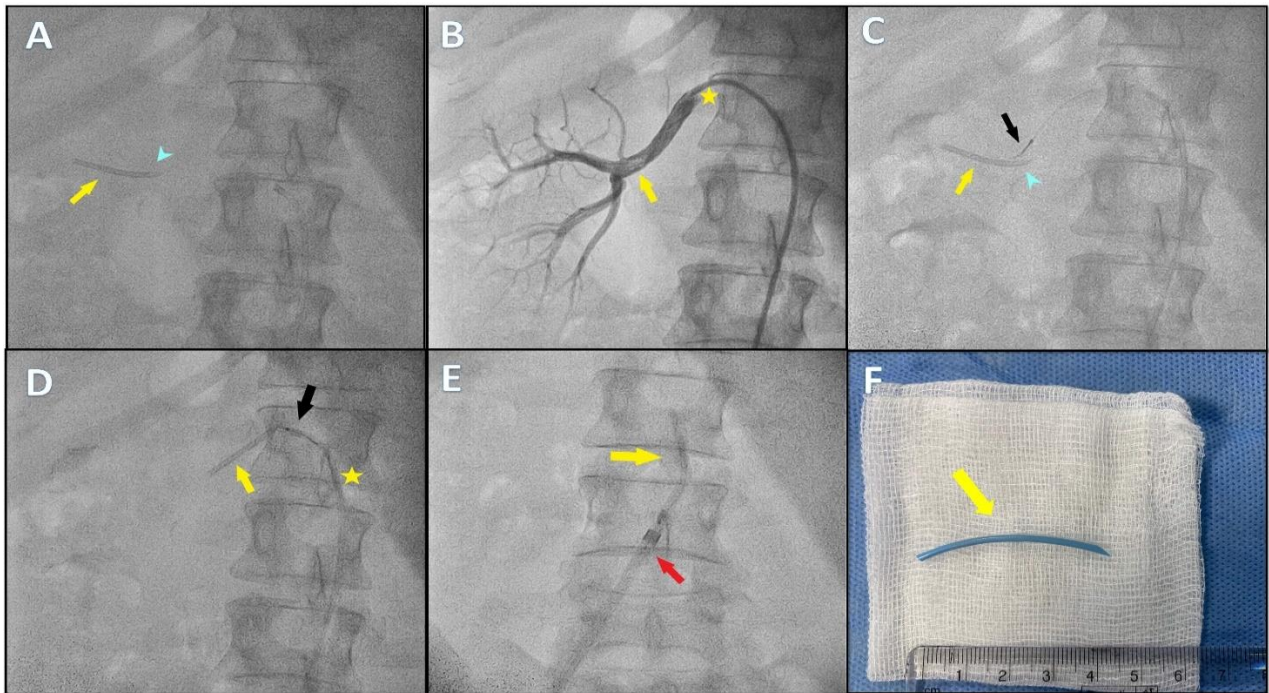


Figure 2 (A–F). Fluoroscopic images of migration and snare retrieval of the catheter fragment from the right renal artery. (A) Antero-posterior view showing the fragmented part of the diagnostic catheter with its sharp proximal edge clearly seen (blue arrowhead). (B) Position of the catheter fragment (yellow arrow) in relation to the right renal artery; simultaneous angiography (white star) shows no thrombus, dissection, or flow limitation in the vessel. (C) The catheter fragment (yellow arrow) being grasped at its proximal edge with an Ensnare (6–10 mm) device (black arrow). (D) Catheter fragment (yellow arrow) held by the Ensnare device (black arrow) and withdrawn as an assembly to the tip of the guiding catheter (yellow star). (E) Retrieval of the catheter fragment (yellow arrow) with the Ensnare device into an 8 Fr long femoral sheath (red arrow). (F) Ex vivo image after retrieval showing the exteriorized broken catheter fragment (yellow arrow); the sharp proximal edge is clearly visualized.

Discussion

Retrieval failure of intravascular foreign bodies is associated with a combined morbidity and mortality rate of 71%.¹⁰ Although surgical retrieval is also associated with high morbidity, retaining fragments in situ can lead to dual outcomes, ranging from event-free survival to serious complications.¹¹

Consequently, percutaneous retrieval has become the preferred procedure because it is safe and is associated with lower morbidity. Several factors increase the risk of catheter (including diagnostic, guide, or guide-extension catheters) kinking, knotting, fragmentation, and subsequent embolization.^{8–12} These factors are listed in (Table 1).

Table 1. Factors contributing to catheter fragmentation	
Categories	Contributing Factors
Patient-Related	- Elderly age - Female sex - Comorbidities
Anatomical	- Vessel bends and tortuosity - Calcification - Spasms - Severe occlusion soon after an acute bend (or a combination of these factors)
Catheter-Related	- Manufacturing defects - Polymer aging - Inherent catheter design (junction of braided and nonbraided parts) - Frequent reuse leading to catheter wall delamination and tip separation - Improved catheter designs (shaft made kink-resistant with softer and atraumatic tips) - Development of more flexible guide extension catheters - Bending and over-rotation - Excessive clockwise or counterclockwise rotation
Operator-Related	- Vigorous manipulation against resistance - Forceful withdrawal of the entrapped catheter - Advancing a guidewire forcefully through a kinked segment - Failure to recognize signs of a kinked catheter (eg, disappearance of arterial pressure waveform, failure of torque transmission from hub to tip, and failure to visualize catheter under fluoroscopy)

Typically, more than one factor is involved. Catheter fragments can vary in their dimensions. Sometimes, only the ring tip may be embolized; these fragments are usually short with circular or elliptical orifices. Fragments can have sharp edges from tangential breakage, making them more likely to become embedded in vessel walls and potentially risk dissection or tearing during retrieval attempts.

The site of embolization depends on the route of entry; the length, stiffness, and shape of the fragment; and the anatomy of the vascular tree.¹² Retrieval can be attempted using a variety of tools and techniques,⁹ such as baskets (eg, Dotter or Dormia); snares (eg, loop, gooseneck, or ensnare); indigenously made loop snares; paired guidewires knotted together (double or triple wire); balloon catheters; and biopsy forceps.

The risk of percutaneous retrieval must be weighed against the potential for the embolized fragment to interfere with vital structures or to cause complications such as perforation, thrombosis, or infection. In some cases, very small fragments may be left in an occluded vessel because they can become endothelialized and remain asymptomatic during long-term antiplatelet therapy.¹³

Recommended preparatory steps before attempting retrieval include upsizing the arterial access sheath to 8F or 9F based on fragment dimensions; administering intracoronary vasodilators to relieve spasm; maintaining an ACT of 300 to 350 seconds with additional heparin to prevent thrombus formation; passing a second wire and balloon to dilate the area of entrapment and stabilize the fragment; positioning the retrieval catheter coaxially to the fragment for smooth extraction; and considering a second arterial access site if necessary.^{14,15}

The strategy and choice of retrieval hardware depend on the location, lie, length, shape, and size of the catheter fragment, as well as the associated risks. Conventional snares are effective for proximal fragments but may cause dissection or vessel closure when used in distal vasculature. In contrast, the balloon method is simple, safe, and cost-effective for both proximal and distal fragments.¹⁴ Stabilizing the catheter fragment with a guidewire before balloon-assisted retrieval is critical for successful outcomes.¹⁵

The choice of retrieval technique should be

tailored to the aforementioned factors, availability, and operator expertise. Nevertheless, no single technique is universally successful. Interventionists should therefore be familiar with multiple retrieval methods so that these may be used synergistically.

Prevention of catheter breakage is paramount. Once a catheter kink or knot is suspected and identified, further rotation of the catheter should be minimized. In most cases, advancing a 0.035-inch guidewire will straighten the kink and permit exchange for another catheter. The kinked catheter should not be pulled forcefully through the femoral arterial sheath because it can become entrapped and transected. When a partial catheter fracture is identified, a guidewire should be passed through the fragment before any attempt is made to withdraw the catheter.¹⁵

In the first case, the “razor effect,” caused by rapid withdrawal of the guidewire against a catheter tip abutting a calcified valve, resulted in avulsion of the relatively soft catheter tip. Balloon-assisted retrieval was considered relatively safer given the size, coaxial alignment, and distal location of the fragment, where snaring may not be feasible.

In the second case, vigorous torquing and manipulation of the catheter in the setting of underlying tortuous arterial anatomy led to catheter fragmentation. Snare retrieval was selected because of the proximal location and the anticipated difficulty in advancing a guidewire through the tangentially cut end of the fragment. Snaring is a reliable method for retrieving embolized fragments from the aorta or the proximal portion of a vessel.

Conclusion

Percutaneous retrieval of broken catheter fragments requires careful planning, familiarity with retrieval devices, and improvisational skills. Successful outcomes depend on prompt recognition of the complication, appropriate technique selection, and preparedness for potential bailout strategies. All interventional catheterization laboratories should be equipped with appropriate retrieval systems and trained staff to manage such complications. Avoidance of reused hardware, together with strict adherence to fundamental principles of intervention during hardware manipulation, can prevent most of these events.

Declarations:

Ethical Approval

Ethical approval was not required for conducting this research.

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Conflict of Interest

The authors report no conflict of interest.

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