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CASE REPORT

INTERMEDIATE

CLINICAL CASE

What *Knot* to Do

Retrieval of a Kinked and Trapped Coronary Catheter

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ABSTRACT

Diagnostic coronary artery catheter knotting and kinking are uncommon but potentially catastrophic complications. Our case emphasizes the importance of avoiding this problem and provides recommendations for catheter retrieval in the unlikely event of this complication. To our knowledge, the technique used in our case has not been described before. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2020;2:1657–61) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 76-year-old man was transferred to our institution with reports of shortness of breath and peripheral edema. Physical examination was pertinent for blood pressure of 159/70 mm Hg, heart rate of 71 beats/min, oxygen saturation of 91% on room air, regular cardiac rhythm, a mechanical click from a prosthetic heart valve, and intact distal pulses.

LEARNING OBJECTIVES

- To understand the predisposing factors and mechanisms that lead to kinking and trapping of a coronary catheter, which is an uncommon, but potentially morbid complication of left heart catheterization.
- To discuss strategies to kinking and trapping of a coronary catheter, as well as percutaneous approaches to retrieve a kinked coronary catheter safely.

PAST MEDICAL HISTORY

The patient had undergone mechanical aortic valve replacement and had an implantable cardioverter-defibrillator.

DIFFERENTIAL DIAGNOSIS

Congestive heart failure and other noncardiac causes of dyspnea and peripheral edema were included in the differential diagnosis.

INVESTIGATIONS

Serial troponin levels were within the normal range. Echocardiography demonstrated a reduced left ventricular ejection fraction at 45%. He was referred for invasive coronary angiography (ICA) to rule out an ischemic cause for the new onset cardiomyopathy. ICA was performed through a right radial approach. A 5-F Judkins right 4 (JR4) diagnostic catheter (Merit Medical Systems, South Jordan, Utah) was advanced over a 0.035-inch guidewire into the ascending aorta. Multiple attempts were made to engage the right

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ABBREVIATIONS AND ACRONYMS

FA = femoral artery

IA = innominate artery

ICA = invasive coronary angiography

JR4 = Judkins right 4

coronary artery without success because of severe tortuosity of the innominate artery (IA) and the takeoff of the coronary artery. We eventually lost the pressure waveform and, on troubleshooting, found that we could not aspirate or torque the catheter. A kink was noted in the middle portion of the catheter on fluoroscopy.

MANAGEMENT

Multiple attempts to release the kink were unsuccessful, such as gently torquing the catheter in the opposite direction and then trying to pass a 0.035-inch guidewire followed by a 0.014-inch coronary guidewire.

With conservative measures unable to resolve the kink and thus allow for withdrawal of the JR4 catheter, it was decided to attempt to retrieve it through the left common femoral artery (FA). This artery was accessed under ultrasound guidance. The access site was "pre-closed" using 2 Perclose Proglide sutures (Abbott, Abbott Park, Illinois) over a standard 0.035-inch guidewire. A 7-F sheath (Terumo, Tokyo, Japan) was placed. We then advanced a JR4 catheter from the left FA to the tortuous IA (Figure 1), over the same 0.035-inch guidewire, which was then exchanged for a Glidewire Advantage guidewire (Terumo). This was used to navigate the IA and then pass down into the right brachial artery. The femoral JR4 catheter was removed, leaving the Glidewire in place, and over this a Quick-Cross catheter (Philips, Amsterdam, the Netherlands) was passed into the right brachial artery. The Glidewire was exchanged for an Amplatz Super Stiff guidewire (Boston Scientific, Marlborough, Massachusetts), after which the Quick-Cross catheter was removed. At this point the left FA 7-F sheath was removed, leaving the Amplatz Super Stiff guidewire in place. Over this, a long, 80 cm × 14-F sheath (Cook Medical, Bloomington, Indiana) was gradually advanced from the left FA all the way to the IA. Using a sheath that had a diameter large enough to accommodate a catheter folded back on itself afforded both options of retrieving the trapped catheter through a snaring device through the sheath or en bloc while removing the large-bore sheath.

The kinked JR4 catheter was able to be advanced approximately 20 cm into the distal end of the 14-F sheath. We then advanced a standard 0.014-inch coronary guidewire from the hub of the 14-F sheath into the IA past the kinked catheter that now lay within the sheath. Over this guidewire, a 5-mm coronary noncompliant Trek balloon (Abbott) was delivered immediately adjacent to the JR4 catheter within the 14-F sheath, where it was inflated to rated burst pressure, thus trapping the JR4 catheter against the inner wall of the 14-F sheath (Figure 2).

The hub of the JR4 catheter, at the radial artery end, was now cut to allow the 14-F sheath with the JR4 catheter trapped within it, to be pulled from the left common FA, thus extracting the JR4 catheter from the body. The previously deployed Perclose Proglide sutures were immediately tightened to achieve hemostasis. To verify adequate hemostasis, contralateral access was obtained in the right FA, and

FIGURE 1 Angiogram Demonstrating Trapped JR4 Catheter Within the Tortuous Innominate Artery

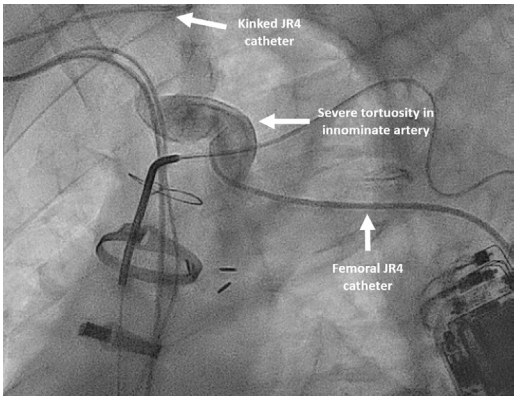
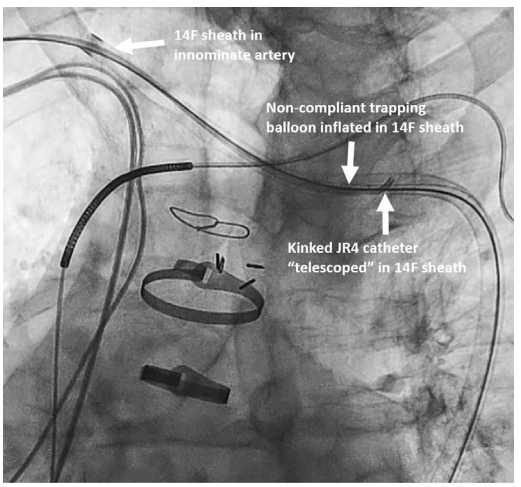


FIGURE 2 Angiogram Showing Kinked Catheter Retrieval



The image shows our approach to retrieval of the kinked JR4 catheter by telescoping it into a retrograde 14-F sheath and stabilizing it in the sheath with a balloon.

TABLE 1 Tips to Prevent Catheter Kinking

1. Remain cognizant of vascular tortuosity, while performing catheter manipulations.
2. Avoid torquing catheters more than 180°.
3. Maintain a guidewire through the catheter.
4. Pay close attention to loss of torque, pressure waveform, or an inability to aspirate a catheter.
5. Take care when using catheters smaller than 6-F in caliber because they may be more prone to kinking.
6. Consider using a long sheath if extensive vascular tortuosity is noted.
7. Consider a left radial artery approach because of the lower prevalence of left-sided brachiocephalic tortuosity, especially in older adults.

TABLE 2 Summary of Various Techniques to Retrieve Kinked and Trapped Coronary Catheters

Blood pressure cuff inflation on ipsilateral brachial region followed by gentle untwisting of catheter (4)
Amplatz Goose Neck Snare (Boston Scientific, Marlborough, Massachusetts) to catch tip of catheter, followed by unraveling of knot in a large-caliber vessel (5)
EN Snare catheter (Merit Medical Systems, South Jordan, Utah) to capture distal tip of kinked catheter, followed by twisting of distal and proximal ends of kinked catheter in opposite directions to unravel knot (6)
Cutting hub of catheter, placing long sheath over catheter, and dragging kinked segment into the sheath to straighten (7)
Balloon-assisted trapping and removal of kinked catheter through a large-bore sheath

ipsilateral iliofemoral angiography was performed. The patient tolerated the procedure well and had no apparent complications when he left the cardiac catheterization laboratory.

DISCUSSION

Catheter knotting during ICA is an uncommon but recognized complication, usually occurring during manipulations while intubating the right coronary artery (1). This has been reported to be related to higher torque buildup in the proximal portion of the catheter during manipulations, compared with the distal end, in the setting of vascular tortuosity (2). Indeed, this condition precipitated the situation in our case. Points to be kept in mind to help prevent this complication, as summarized in **Table 1**, include avoidance of torquing a catheter more than 180°, being mindful of vascular tortuosity if encountered, maintaining a guidewire through the catheter, and paying attention to situations where loss of torque is observed, pressure dampening is noted, or an inability to aspirate the catheter occurs (3). Other elements to consider are the use of long sheaths if considerable vascular tortuosity is noted and that catheters smaller than 6-F are more prone to kinking because of their thin-walled construction.

Once a kink has occurred, techniques to deal with this are anecdotal, with a dearth of randomized data on this topic. A technique has been described whereby the proximal end of the knotted catheter is fixed by inflating a sphygmomanometer cuff in the ipsilateral brachial region, followed by gentle torque of the catheter in the opposite direction of the initial torque to untwist a kinked catheter (4). Another approach involves catching the tip of the kinked catheter by using an Amplatz Goose Neck Snare (Medtronic, Dublin, Ireland) guided by a guiding catheter through the FA, followed by pulling the kinked catheter into a larger-caliber vessel and then unraveling the knot (5). A similar approach, but with a slight modification, is the use of an EN Snare catheter (Merit Medical Systems) to capture the distal end of a kinked JR5 catheter. This is followed by gently pulling and rotating the distal end of the JR5 with the EN Snare catheter while simultaneously rotating and pulling the hub of the JR5 catheter in the opposite direction, thereby unkinking the catheter and allowing for successful retrieval through the radial artery (6). Another report detailed a kinked JL catheter in the brachial segment that was able to be retrieved by cutting the hub of the catheter and replacing the 6-F radial sheath with a long, 5-F sheath while leaving the JL catheter in place to maintain arterial access. The long sheath was then brought to the antecubital fossa, and the kinked catheter was gently pulled back and straightened while being pulled into the long sheath and thus removed (7). All the techniques mentioned here are summarized in **Table 2**. To our knowledge, retrieval of a kinked catheter by using balloon-assisted trapping, as in our case, has not been reported before. **Figure 3** is an algorithm showing factors predisposing to catheter kinking, ways to assess for it, conservative measures to address it, advanced percutaneous techniques for management that can be considered if conservative measures fail, and our strategy that can be used if other measures fall short.

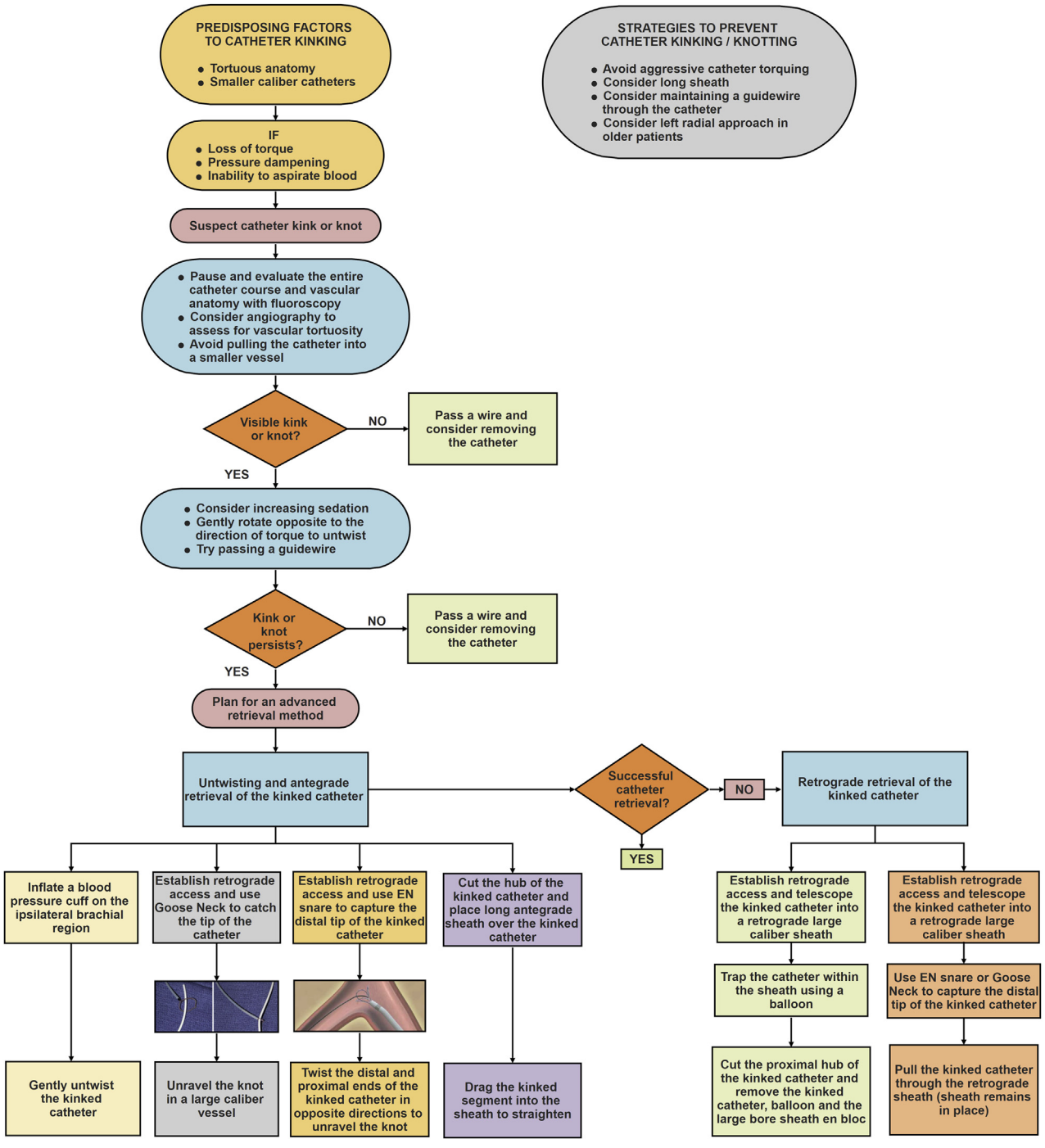
FOLLOW-UP

The patient was medically managed with a plan to return in the future for ischemic evaluation.

CONCLUSIONS

As with most issues in the cardiac catheterization laboratory, preventing a complication is often much

FIGURE 3 Management of Catheter Kinking



easier than managing it. Care must be taken in all aspects while manipulating the catheter, especially within tortuous vasculature. Once the complication is suspected, recognizing it early is paramount; once it has occurred, tailoring retrieval to each individual case is prudent.

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