Entrapment of a Transradial Coronary Catheter

Asif Serajian, DO, Teja Gundala, MD
From West Suburban Medical Center, Oak Park, Illinois.

ABSTRACT: Transradial arterial access for percutaneous angiography and intervention has gained worldwide acceptance in recent years. This method has demonstrated significant reductions in bleeding, access site complications, length of hospital stay, decline in expenses, and improvement in clinical outcomes when compared to femoral and brachial approaches. Despite these potential advantages, transradial access has well-documented complications such as radial artery occlusion, arterial spasm, nonocclusive radial artery injury, hand ischemia, perforation, and pseudoaneurysm. Here, we explore a unique and emerging complication of a kinked and looped coronary catheter in radial or axillary arteries during transradial access for percutaneous procedures. Interventional cardiologists commonly face mild catheter kinking, but frank entrapment of a kinked catheter is a matter of concern. As transradial access becomes more ubiquitous, this unique complication will likely be encountered more frequently. Our goal is to discuss possible etiologies, potential methods of prevention and provide viable documented techniques of successfully resolving this complication.

CASE REPORT

Since its introduction in the early ’90s, transradial access (TRA) has progressively gained worldwide acceptance and has replaced femoral access for percutaneous angiography and percutaneous coronary intervention (PCI) in some countries.1 Norway, Bulgaria, and Malaysia seem to be utilizing TRA the most (70% to 80%), while in United States it has been shown to be the chosen method of PCI in less than 2% of cases.1,2 Transradial access, when compared to the traditional femoral approach, has been proven by strong retrospective and prospective data, in reducing access site complications, length of hospital stay, decline in expenses, and improvement in clinical outcomes.1,3 Studies have also suggested that patients who underwent both femoral and radial approach, prefer the latter due to decreased discomfort.4 Despite these potential advantages, TRA has well-documented complications such as radial artery occlusion, arterial spasm, nonocclusive radial artery injury, hand ischemia, perforation, and pseudoaneurysm.3

As utilization of TRA for PCI has tremendously increased in recent years, there have been a few case reports highlighting a unique complication of a kinked and looped coronary catheter in radial or axillary arteries. To our knowledge, the first report of catheter knotting and successful unknotting during TRA was described by Dr. Tejas Patel in the May 2011 issue of The Journal of Invasive Cardiology.5 Following this, a few more case reports, from all over the world, were published in 2012 regarding this complication. Although these publications reported a very similar complication, each author described a distinct method of resolving this issue. Viable documented techniques of unraveling a kinked and entrapped catheter included the (1) BP cuff technique, (2) femoral snare technique, (3) long sheath technique, and (4) balloon retrieval technique.5-9

As TRA becomes more ubiquitous, this unique complication will likely be encountered more frequently. We faced this exact complication in our cardiac catheterization lab in late 2011, which spurred our interest to explore this topic further. The purpose of this article is to discuss possible etiologies, potential methods of prevention and provide viable documented techniques of successfully resolving this complication.

PLAUSIBLE ETIOLOGIES

Plausible etiologies of kinking leading to immobilization include use of catheters made for femoral approach, tortuosity of vasculature, excessive torquing and manipulation of the catheter, and even vasospasm. Many of the coronary catheters used today for transradial approach are usu-
ally made for transfemoral access. As most operators today prefer the right radial artery (RRA), there is a need to rotate the pre-shaped catheter in an attempt to navigate across the S-shaped morphology of the right subclavian-innominate-aorta access. This consequently prolongs procedure time and also leads to excessive manipulation of the catheter. Excessive manipulation combined with significant subclavian tortuosity results in increased resistance and loss of one-to-one torque. As a result, there is a higher chance of downstream looping and kinking. Further brute manipulation to relieve the loop in the brachial or radial arteries increases the probability of vasospasm, likely due to significant muscular component along with alpha-1 receptors, resulting in entrapment.

**METHODS OF PREVENTION**

Potential methods of prevention of looping include using the left radial artery (LRA) for TRA, refraining from rotating the catheter greater than 180°, maintaining a guidewire, and also careful monitoring of the pressure tracings. Ninety percent of interventional cardiologists prefer RRA for TRA. While severe right subclavian tortuosity is observed in 10% of patients undergoing TRA for coronary procedures, there is also a double incidence of operator-reported moderate subclavian tortuosity with the RRA compared to LRA. Subclavian tortuosity is associated with increased catheter manipulation and procedural time. Hence, using the LRA as the access site could potentially decrease procedural time, unwarranted manipulation, decrease resistance, increase one-to-one torque, and likely reduce downstream looping.

Refraining from rotating the catheter greater than 180° prevents buildup of torque proximally that is not transmitted to the catheter tip. Hence, there is greater control of the distal catheter and decreased unforeseen catheter behavior proximally, which could prevent looping and kinking. Close observation of the pressure curve while torqueing could also prevent looping. When there is partial dampening of the pressure curve, suggesting loss of advancement of the catheter, applying further torque could again result in unanticipated catheter behavior. Many operators have also suggested maintaining a guidewire within the catheter to enhance one-to-one torque if needed.

**METHODS OF RESOLUTION**

Viable documented techniques of unraveling a kinked catheter include the BP cuff technique, femoral snare technique, long sheath technique and balloon retrieval technique. The following techniques are mentioned in chronological order of their published dates in various scholarly journals.

**BP Cuff Technique**

To our knowledge, Tejas Patel et al described the first report of catheter knotting and successful unknotting during TRA in 2011 in *The Journal of Invasive Cardiology*. This case highlights a simple, yet effective, technique of unknotting a coronary catheter trapped within the radial artery using a routine sphygmomanometer.

While engaging the right coronary artery via right TRA, authors noted difficulty in advancement of the catheter tip. There was dampening of the pressure tracings along with difficulty injecting contrast media. Fluoroscopic investigation revealed a tight knot of the 5 Fr Tig catheter (Terumo Corporation) in the right radial artery. Initial gentle counterclockwise manipulations along with introduction of a standard 0.035” guidewire were unsuccessful. External fixation of the distal end of the catheter manually in the brachial region was also fruitless due to significant adipose tissue. Finally, a BP cuff was fixed in the brachial region, distal to the knot, and inflated to 200 mmHg while the catheter was torqueing.

![Figure 1. Tight knot of the 5 Fr Tig catheter in the right radial artery (A). Blood pressure cuff fixed in the brachial region, distal to the knot, inflated to 200 mmHg.](image)
eter was rotated in the counterclockwise direction proximally (Figure 1). This maneuver unraveled the knot and allowed free movement.

**Femoral Snare Technique**

In January of 2012, two more case reports regarding catheter entrapment during TRA were published from two different parts of the world. One was by Khoubyari et al from The University of Arizona and the other by Kim et al from The Catholic University of Korea in Suwon, South Korea. Interestingly, both of the authors employed a snare via the right femoral artery to resolve this complication.

Khoubyari et al describe a case of catheter entrapment and kinking in the radial artery, which was successfully removed by using a gooseneck snare via the transfemoral route. During right TRA, authors describe difficulty in engaging the RCA necessitating multiple attempts of manipulating the catheter to gain access. Fluoroscopic investigations revealed a 360° kinked 5 Fr JR5 (Cordis Corporation) catheter within the radial artery. Insertion of a standard guidewire along with antispasmodic medication cocktail was unsuccessful. To resolve this complication, a 7 Fr EN Snare (Merit Medical) catheter was introduced through a 7 Fr sheath via the right common femoral artery. The 7 Fr EN Snare catheter was advanced into the aortic arch and the distal end of the 5 Fr JR5 was captured (Figure 2). While simultaneously manipulating the catheters in opposite directions, the JR5 catheter dislodged from the right radial artery and successfully retrieved through its radial sheath.

Kim et al also described a case where a kinked and entrapped catheter in the right radial artery during TRA was removed using a GooseNeck snare (Covidien). During right TRA, authors describe much difficulty engaging the coronary ostium due to significant innominate tortuosity. After several attempts of manipulating the 4 Fr catheter, it was noted to be kinked within the small right radial artery. Attempts to unravel the catheter caused significant pain to the patient. To resolve this complication, authors employed an 8 Fr JL4 guiding catheter via the right femoral artery and pulled the entrapped 4 Fr catheter into the descending aorta from the ostium. A 6 Fr Amplatz GooseNeck Snare Kit (Covidien) was introduced via the 8-Fr guiding catheter and the distal tip of the entrapped 4 Fr catheter was controlled and pulled up into the brachial artery (Figure 3). Using a 0.035˝ J wire (Abbott Vascular) the kinked 4 Fr catheter was unraveled and safely removed through the right radial artery.

**Long Sheath Technique**

In September of 2012, Waked et al described an approach of resolving a kinked catheter within the brachial artery using a 5 Fr long sheath. The authors did not describe whether they attempted this on the right or the left.
While manipulating a 5 Fr JL4 (Cordis Corporation) through a 6 Fr sheath to engage the left coronary artery, authors noted loss of catheter advancement due to spasm. Fluoroscopy revealed a kinked catheter within the brachial segment. Initial gentle maneuvers to unravel the catheter were unsuccessful. To resolve the issue, the proximal end of the JL4 was cut and the 6 Fr 12 cm sheath was exchanged with a 5 Fr long sheath while the trapped JL4 acted as a guidewire. Under fluoroscopy, the long 5 Fr sheath was advanced to the antecubital fossa (Figure 4) to the base of the kink, and the trapped JL4 was gently pulled back, unraveling the kink, and slipped back in the sheath.

**Balloon Retrieval Technique**

In September of 2012, Layland et al published a unique method of rescuing a kinked coronary catheter in the axillary artery during coronary catheterization via TRA. This case is different from the others not only in terms of the method, but also in that the kinking occurred in the larger axillary artery upon removal, not advancement of the catheter.

During left TRA, after successfully treating occlusive coronary disease, authors note kinking of an EBU 3.5 guiding catheter (Medtronic) within the axillary region upon retrieval. Gentle catheter manipulation, rotation, use of a standard 0.035˝ guidewire, and a super-stiff wire were unsuccessful. To resolve the problem, a 6 Fr JR4 was used to gain access to the kinked catheter via femoral approach. The JR4 was advanced close to the distal tip of the kinked EBU guiding catheter, and a Whisper MS wire (Abbott Vascular) was advanced through the JR4 and into the kinked EBU. Next a 3.0 mm x 15 mm NC balloon (Abbott Vascular) was passed through the JR4 over the MS wire and was inflated within the distal end of the kinked EBU catheter (Figure 5). With gentle backward traction, the JR4 and the EBU were retrieved into the ascending aorta and the kink was unraveled using the JR4/balloon apparatus allowing the EBU catheter to be removed through the radial access.

**DISCUSSION**

Since its introduction, TRA has gained worldwide acceptance. As TRA becomes more commonplace, complications related to this procedure, including the unique issue of kinked coronary catheter, will likely be encountered more frequently. Our goals are to shed light upon this emerging complication and discuss possible etiologies, discuss potential methods of prevention, and provide viable documented techniques of successfully resolving this complication.

We believe if a coronary catheter were to become kinked and immobilized during TRA, it would be logical to first attempt noninvasive maneuvers of inflating a BP cuff distal to the kink and gently manipulating the proximal catheter to unravel the kink. If this does not resolve the complication, depending on the proximity of the kink from the access site, one can attempt to dislodge the kink using a long sheath as described above. If this were also unsuccessful, one could attempt more invasive methods such as the femoral snare technique or the
balloon retrieval technique. Amongst these, depending on the situation, we prefer the balloon retrieval technique as one can avoid inserting a large-caliber femoral sheath and also have true control of both catheters at all times. Perhaps if all else fails, it would be wise to have a vascular surgeon in the cardiac catheterization lab as one proceeds further.

**Editor’s Note:** Disclosure: The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. The authors report no disclosures in relation to the content of this manuscript.

Manuscript received June 25, 2013; provisional acceptance given July 10, 2013; manuscript accepted August 1, 2013.

Address for correspondence: Asif Serajian, DO, 183 N. Addison Ave., Ste. 170, Elmhurst, IL 60126, United States. Email: aserajian1@gmail.com

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