

# Knots in the cath lab, an embarrassing complication of radial angiography

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## ABSTRACT

Most case reports or series describe knots in the venous system such as knots of Swan-Ganz catheters, pacing wires or thermolysis catheters. Knots during radial angiography are relatively rare. Here we describe a simple method of unravelling a radial knot via the femoral route, together with a review of the literature on knots in the catheterisation laboratory and the techniques to deal with them.

Most knots in the catheterisation laboratory in literature have been described on the right side of the heart during Swan-Ganz pulmonary artery monitoring, superior vena cava cannulation, pacing wire insertion or right heart catheterisation.<sup>1 2</sup>

Thejes Patel had described a knot during radial coronary angiography and its removal.<sup>3</sup> Some of these knots have required surgical removal.<sup>4</sup> Here we describe a patient with a knot during radial angiography that ended up with a second knot when we tried to take it out and the steps we took to undo the knot. The patient was a 43-year-old man who presented with chest pain of 1-day duration, was diagnosed to have non ST-elevation myocardial infarction and was scheduled for coronary angiography.

A right radial access was chosen and the right radial artery was cannulated with a 5 F catheter. Cannulation of the left main artery was attempted, but pressure damping was noted in the pressure waveform monitoring and the catheter would not move. On tracing the catheter course it was found that there was a knot in the catheter at the level of the subclavian artery (figure 1). Initially, an attempt was made to untwist the catheter but it was unsuccessful. A guide wire inserted would not go through the catheter. A Terumo wire or stiffer wires did not go through the catheter lumen. In spite of gentle traction on the catheter the knot did not unravel (figures 2 and 3). When the loops were screened again, it was found that a second knot had formed. Thereafter, a 8 F catheter was inserted through the right femoral artery. An Amplatz goose neck snare was passed through the 8 F catheter. We attempted to catch hold of the knotted catheter with this but could not do so. So a custom-made snare was made with a long 0.014 inch 300 cm coronary guide wire. The lower end of the catheter was held with this. Attempts at holding the radial catheter were not very helpful, but during one attempt the patient complained of severe chest pain and the knot became unravelled. The catheter was then pulled out.

## DISCUSSION

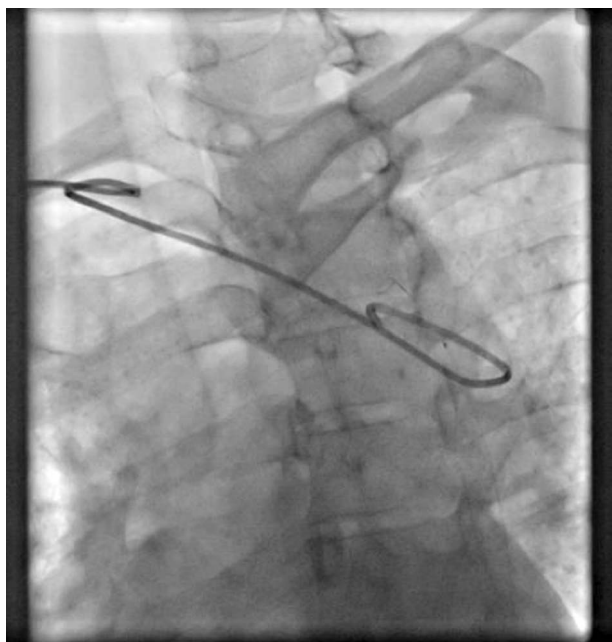
Thejes Patel<sup>3</sup> and others have described a new method to tackle knots during radial

catheterisation. They have suggested that the most common cause of a radial knot is overtorquing while trying to rotate anteriorly towards the right coronary artery ostium. They recommend fixing the catheter so as to unknot it. For this they recommend inflating a sphygmomanometer cuff to above 200 mm Hg. This is supposed to fix the catheter so it can be turned in the other direction.

In this patient we tried to get hold of the catheter with a custom-made snare, made out of a coronary guide wire. Femoral access was used and the snare placed over the end of the catheter that had been pushed into the ascending aorta, the arch and then the descending aorta. When the snare caught hold of the end of the knotted Tiger catheter, the patient experienced a mild pain during manipulation of the catheter and the catheter came out. In this case, a femoral approach was used to fix a knotted radial catheter and surgery was avoided. We had previously described a femoral access approach to radial spasm.<sup>2</sup> For that report, there was prolonged radial spasm, lasting more than 4 h. In that case, we first gave extra heparin. Then we cannulated the right femoral artery and using a 6 French right Judkins catheter, we cannulated the right subclavian artery. Through this, we gave one ampoule intravenous papaverine. The patient sweated profusely, had tachycardia but after 10 min we were able to pull out the radial catheter. Hence, sometimes the femoral route may help to resolve problems associated with the radial approach. But, subsequent to these two cases we have not had much problem in any radial case.

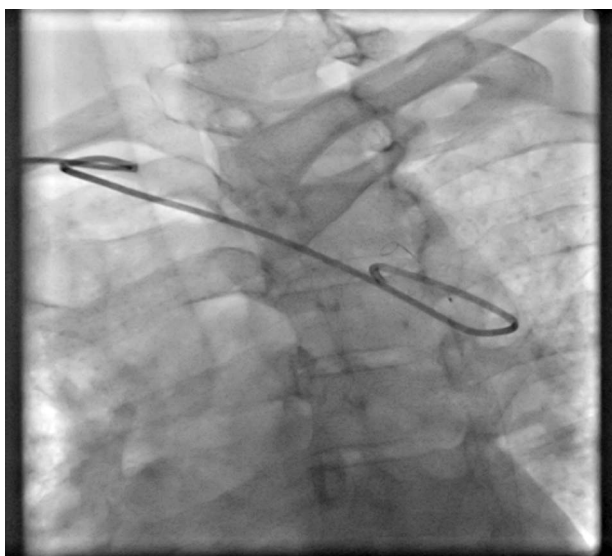
Why do knots occur? There are many causes for this. This may occur during right heart catheterisation or during pulmonary artery wedge pressure recording if the procedure is done blindly. When too much excess length is introduced especially in the right ventricle, looping occurs. Some authors have recommended that not more than 10 cm of catheter should be introduced at a time, and a close watch be kept on the pressure tracing. A classical case of a knot was described by Daum and Schapira<sup>1</sup> in 1973. They advanced a catheter 40 cm into the basilic vein of the right arm. At this time, no atrial pulsations were seen so they withdrew the catheter to 20 cm or 30 cm. Here, they felt a resistance. Resistance can be encountered commonly on withdrawing catheters in veins because of venous valves. But, in this case they were able to advance the catheter again to 40 cm, and after flushing, they felt atrial pulsations and then the catheter was pushed into the right ventricle and the pulmonary artery. After this the pressure damped again. So in spite of flushing the catheter was damped. So, they tried to remove the catheter, and at about 3–4 cm

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**Figure 1** Knot formed during attempted radial coronary angiography. Even on trying to withdraw the catheter the knot did not unravel.

from the skin the catheter could not be pulled out. A knot was found. That was removed with a small surgical incision. They postulated the knot formed at the time of initial introduction of the catheter, and that inflation of the balloon before entering the superior vena cava would have prevented the knot. Baldi *et al*<sup>5</sup> have described complete knotting of a catheter and a non-surgical method of removal. This was a knot in a pacemaker catheter. The patient had first degree aortic valve block and rate dependent left bundle branch block so a His bundle ECG was done. A USCI, bipolar catheter was put in the femoral vein but after a few centimetres a resistance was felt, so the catheter was manipulated back and forth. At this time fluoroscopy was done and a knot was found in the catheter that had formed at the junction of the right iliac vein with the inferior vena cava. This was removed by to and fro movement of the catheter under



**Figure 2** A knot during radial angiography.



**Figure 3** Again trying to withdraw the radial catheter, but it was stuck.

fluoroscopy. Whether or not the catheter can be removed non-surgically depends on whether the knot is complete or incomplete. Kao *et al*<sup>4</sup> have described a knot detected during trans esophageal echo. This was a continuous cardiac output monitoring catheter. Here, they advised to avoid knotting of a catheter as described as follows: as the catheter is advanced change in waveforms should occur, if it does not occur at 10 cm intervals after the right atrium had been entered it is possible a knot has formed. In their patient at 35 cm, no pulmonary artery pressure tracing could be obtained in spite of advancing the catheter 10 cm repeatedly. They also encountered resistance while trying to pull out the catheter. This knot was removed surgically as the patient was already undergoing cardiac surgery.

Reports of guide wires knotting have also been described. Kim *et al*<sup>6</sup> describe a radial artery guide wire knotting during radial angiography. Here, after puncture the operator found it difficult to advance the guide wire, and tried to remove the guide wire but it would not come out. It had formed a knot so the surgeon was called to take out the knot by endarterectomy.

There are different methods for removing knots. One method is to pull the knot against an introducer sheath. A second method is to unknot the knot, by gentle clockwise or counter-clockwise rotation. Another involves using another access with a snare or biopptome catheter. Some authors also describe a grabbing forceps for reduction of knots.<sup>7</sup> Tanner described five cases of knots from the femoral route, three at the level of the right common iliac artery, one at the lower abdominal aorta, through a 8 F introducer sheath from the left femoral access; a grabbing forceps, made by Olympus–Keymed (Southend UK) for endoscopic purposes was used (No FG-4 L-1) The jaws extend about 1 cm beyond the end of the shaft. The ends of the jaws lock with a W-shaped jaws mechanism, thereby providing traction up to about 1.5 kg. At a site above the knot the catheter with a knot is snared and fixed in position. This permitted effective manipulation of the coronary catheter from its proximal end allowing knot reduction. In all the cases described by Tanner

the knot was clockwise, so simple anticlockwise rotation was enough to unravel the knot further. Strangely as described by Patel, most of the procedures done were right coronary angiograms. Only loose knots can be removed by snares or other catheters hooking the knot. In spite of all these techniques there are reports describing leaving a catheter in situ for 16 months. Meisters *et al*<sup>8</sup> have described a catheter lodged around the tricuspid valve apparatus, and since the patient was very sick, no surgical removal was possible. The PAC-Man trial and the ESCAPE trials<sup>9</sup> have listed the complications of pulmonary artery monitoring. Catheter knotting occurred in 1% of cases. Catheter knotting should be suspected when resistance is met on withdrawal, and forceful withdrawal can cause intracardiac injury. If more than 10 cm distance of catheter is required from the right ventricle, or more than 50 cm length from the right internal jugular vein, then catheter looping or knotting should be suspected. When the patient complains of pain during withdrawal, one must always have a suspicion that the catheter has coiled around an intracardiac structure.<sup>10</sup> Skinner *et al* described a patient who had pain during manipulation of a Cournand catheter. This was removed surgically and was found to be wrapped around the chordae tendineae of the tricuspid valve.

With regards to primary prevention of knots, knots are more likely in persons who have tortuous radial arteries. As persons above the age of 70 years also tend to have more tortuous vessels a femoral approach is preferred for these patients.

**Contributors** GKP and BKK created the knot. PNG and SZA removed the knot and SVS helped. All authors have contributed to the paper.

**Competing interests** None.

**Patient consent** Obtained.

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