

# Knotting of a Pulmonary Artery Catheter in the Superior Vena Cava

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Catheter knotting is a rare but severe complication of pulmonary artery catheterization. We present a case in which knotting of the pulmonary artery catheter occurred during tricuspid valve repair in a 29-year-old man. We attempted to uncoil the knot with a guidewire under fluoroscopy, but final successful removal of the knot in the pulmonary artery catheter required surgical intervention. Related instances in the literature are reviewed, and appropriate management and prevention strategies are discussed. ( *Mid Taiwan J Med* 2007;12:230-4 )

## Key words

intensive care, pulmonary artery catheterization, pulmonary artery catheter complications

## INTRODUCTION

The pulmonary artery catheter (PAC) is associated with numerous complications during insertion and management. The American Society of Anesthesiologists Task Force reported that serious complications caused specifically by pulmonary artery catheterization occur in 0.1% to 0.5% of PAC-monitored surgical patients [1]. Knotting of the PAC is one of the most serious complications. The first case of intravascular knotting was published by Johansson et al in 1954 [2] and pulmonary artery catheter knotting had the highest mortality of intravascular knots, reported at a rate of 6/53 (11%), in a review by Karanikas et al [3]. We report a case of postoperative pulmonary artery catheter knotting within the superior vena cava. We also review strategies for managing and preventing this condition.

## CASE REPORT

A 29-year-old man with a history of heroin

abuse was admitted to the surgical intensive care unit (SICU) after tricuspid valve repair for infective endocarditis. A Swan-Ganz catheter (7.5 French thermodilution heparin-coated pulmonary artery catheter) was inserted percutaneously through the right internal jugular vein and fixed at the 50 cm mark with assistance from the surgeon for post-operative hemodynamic monitoring. Wedge position was confirmed by pressure wave and chest X-ray (CXR) (Fig. 1) in the SICU.

Wedge pressure was lost the following day and failed to recover. Under continuous pressure monitoring, the catheter was withdrawn into the right atrium from where we attempted to reinsert the PAC into the right internal jugular vein to the 70 cm mark; however, every attempt failed. We also were unable to withdraw the catheter from the sheath because of resistance at the 30 cm mark. A portable CXR was taken to visualize the position of the catheter; the image revealed a knot in the catheter in the right internal jugular vein (Fig. 2). A cardiologist was consulted, but was unable to release the knot with a guide wire under fluoroscopy (Fig. 3). Cardiovascular surgeons were consulted; they removed the pulmonary artery catheter knot using a cut-down procedure

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above the clavicle under fluoroscopy. The stump of the catheter, together with the knot, was pulled out through an incision in the internal jugular vein (Fig. 4).

**DISCUSSION**

Catheter knotting may lead to thrombosis, arrhythmia, or infection, and can cause vein rupture if withdrawn by force. According to Karanikas et al, the reported incidence of PAC knotting increased after the introduction of the pulmonary artery catheter [3]. The risk of knot formation while passing a catheter between the

chordae tendineae is particularly high in patients with tricuspid valve regurgitation [4].

Knotting can be avoided by continuous monitoring of pressure waves during insertion and manipulation. The length of insertion is another very important factor in preventing the PAC from looping in heart chambers. Partial loops with large diameters can form in the right atrium or ventricle if excess length is inserted. Lopes et al recommended that no more than 10 to 15 cm be inserted into the right atrium or ventricle during an attempt to position the catheter [5]. If an attempt fails, the catheter must

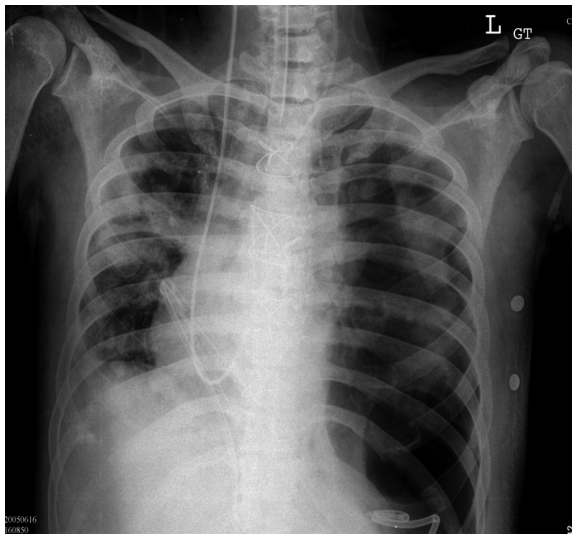


Fig. 1. Initial position of Swan-Ganz catheter after surgery. The tip of catheter is at adequate position and without knotting.

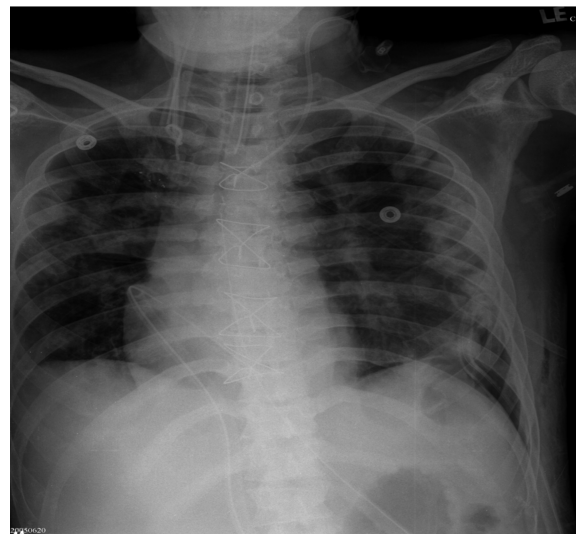


Fig. 2. The Chest radiography shows knotting of catheter in superior vena cava one day after reposition failed.

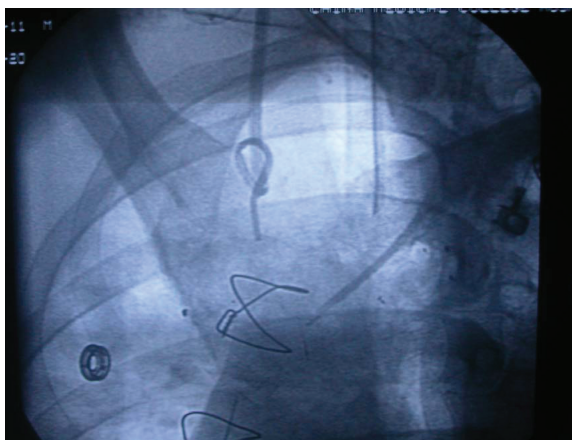


Fig. 3. Failure to untie the knot with guidewire under fluoroscopy.

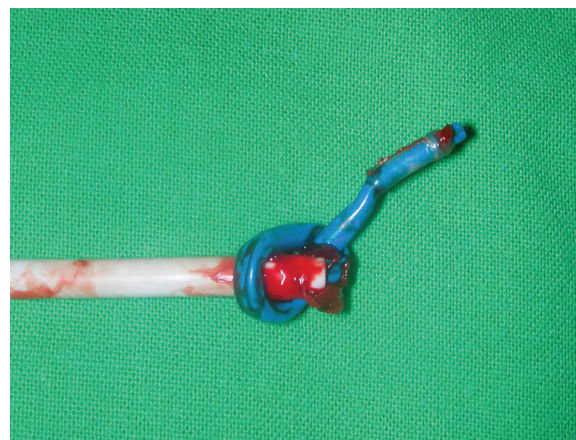


Fig. 4. Knotted Swan-Ganz catheter after surgical removal.

be gently withdrawn into the right atrium before a new attempt is made to direct it to the pulmonary artery. The catheter should be carefully withdrawn to the 30 cm mark and re-advanced, avoiding careless maneuvers. If resistance persists during these maneuvers, the procedure must be stopped, and CXR must be obtained to rule out a looping or knotting formation.

The risk of complications is high when resistance is encountered during removal of a catheter. If the PAC becomes knotted, a movable core-guided wire under fluoroscopic control can be used to untie the knot [5]. An alternative approach is to tighten the knot as much as possible so that it can be removed through the vein of insertion [6]. A deflection wire can also be used. The wire is locked in the first turn of the knot and the catheter is withdrawn. The knot is released using a retrieval basket [7], a loop-snare [8] formed by a doubled-over guide wire and endo-myocardial biopsy forceps [9], or even an angioplasty balloon (which, when inflated, expands the diameter of the knot). Open surgical removal is reserved for cases in which the size of the knot is large and many loops are involved—the so called “bow tie” knots—or when intracardiac fixing of the knot is encountered [6]. If knotting occurs and cannot be released by interventional radiological techniques, surgical removal of the catheter is another option, and is necessary in about 34% of PAC knotting cases [3].

The guidelines for pulmonary artery catheter placement [10] state that if a right ventricular waveform is not observed after inserting the catheter to the 40 cm mark, coiling in the right atrium is likely. If a pulmonary artery waveform is not observed after inserting the catheter to the 50 cm mark, coiling in the right ventricle has probably occurred. In our patient, the adequate wedge position was at the 50 cm mark. Therefore, the knot may have formed in the right ventricle as we advanced the catheter to the 70 cm mark before withdrawing it. After placement, PACs soften due to exposure to warm body temperatures, which complicates the re-advancement of the catheter. Injecting small amounts (2 to 3 mL) of icy water will stiffen the catheter and facilitate the procedure.

We first attempted to untie the knot with a guidewire. However, this patient was in critical condition and could not tolerate multiple attempts to remove the knot. Therefore, after several failures, we chose surgical intervention to remove the knot. Fortunately, the knot was able to be withdrawn with the sheath to the internal jugular vein, and was removed superior to the clavicle. If the knot had been inferior to the clavicle, sternotomy may have been necessary to remove the knot.

The benefits of pulmonary artery catheters outweigh the associated complications in selected cardiac surgery patients [11]. Although uncommon, intracardiac knotting of the catheter represents a possible complication associated with PAC insertion. The physician should be aware of the risk for knotting, especially at insertion and when resistance is encountered during removal. Knots that cannot be released by interventional radiological techniques should be managed by surgically removing the catheter.

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## 肺動脈導管於上腔靜脈打結

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肺動脈導管打結是肺動脈導管少數但嚴重的併發症之一，我們報告一個29歲的男性病例接受三尖瓣修復手術但在術後產生肺動脈導管打結。我們先嘗試在X光透視下使用導引線試圖解開結節，但最後靠外科手術移除肺動脈導管。本文除報告本病例外並回顧探討如何預防這種情形的發生及常見各種治療方式。(中台灣醫誌 2007;12:230-4)

### 關鍵詞

重病特別護理，肺動脈導管置入，肺動脈導管併發症

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