Successful retrieval of a knotted pulmonary artery catheter trapped in the tricuspid valve apparatus

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ABSTRACT

We report the case of a 64-year-old patient in whom a pulmonary artery catheter formed a knot fixed within the right ventricle in the region of the tricuspid valve apparatus. Knot formation is a recognized complication associated with pulmonary artery catheters (PAC) insertion. This problem is usually dealt with by simply withdrawing the PAC until the knot impacts onto the introducer and after enlarging the puncture site by a small skin incision removing the introducer-PAC as one unit. However, we recently encountered a situation where the PAC was knotted around the tricuspid valve apparatus and could not be withdrawn. An interventional radiologist was able to unknot the catheter and release it from the tricuspid valve. We reviewed the literature related to this topic. We believe our experience could be of use to others.

Key words: *Invasive hemodynamic monitoring, pulmonary artery catheter, pulmonary artery catheter complications, tricuspid valve*

INTRODUCTION

We had a patient in the operation theatre for off-pump coronary artery bypass surgery. Pulmonary artery catheter (PAC) was inserted, during the insertion process the pulmonary artery catheter formed a knot and was trapped in the tricuspid valve apparatus. Knot formation of PAC is one of the several complications encountered during this procedure. In our patients the pulmonary artery catheter was successfully and non-surgically released from the attachment and extracted by an interventional radiologist under the fluoroscopy.

CASE REPORT

A 64-year-old man with a 20-month history of exertional chest pain presented for elective myocardial revascularization. Past medical history included hypertension, type 2 diabetes mellitus, and hypercholesterolemia. The patient underwent coronary angiogram, which revealed extensive diffuse 3 vessel disease and very poor left ventricular function with an ejection fraction of about 25%. Trans-thoracic echo showed dilated left ventricle with severe left ventricular dysfunction. Recent MRI showed extensive regional wall motion abnormalities, but no late gadolinium enhancement despite wall thinning, suggestive of viable and hibernating myocardium. Preoperative vital signs, physical examination, electrocardiogram, chest X-ray results, and laboratory values were consistent with the patient's underlying conditions and revealed no acute changes in his condition.

Invasive monitoring was inserted in the anesthetic room. This consisted of a brachial arterial line, a right internal jugular central venous catheter, and a sheath for a PAC. A PAC was passed into the pulmonary artery. Attempts to wedge the PAC were unsuccessful and when we tried to withdraw the PAC we found that it was tethered. A transesophageal echocardiography (TOE) confirmed that the PAC was tangled in the tricuspid valve apparatus [Figure 1]. TOE of the knotted PAC in the tricuspid valve apparatus.

The help of an interventional radiologist was sought. Under fluoroscopy the PAC was wired and using traction over the wire the knot was worked along to the end of the catheter and released. This allowed the PAC to be re-floated with a satisfactory pulmonary wedge pressure in the right pulmonary artery. The patient's postoperative course was entirely uneventful. He made good progress in the ward and was discharged home [Figure 2a and b]. X-ray of the knotted PACs.

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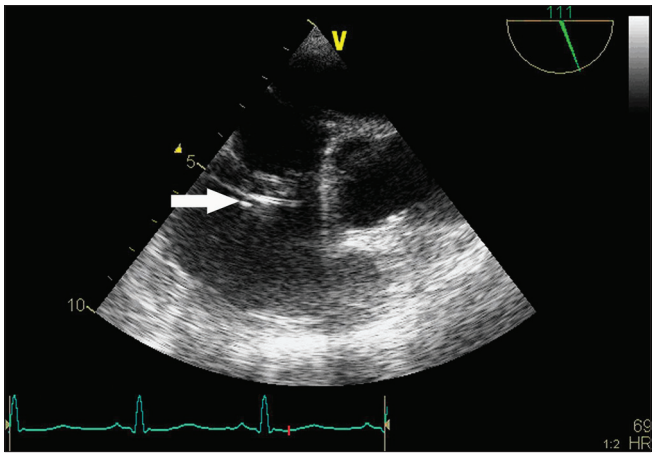

Figure 1: TOE of the knotted pulmonary artery catheter in tricuspid valve apparatus

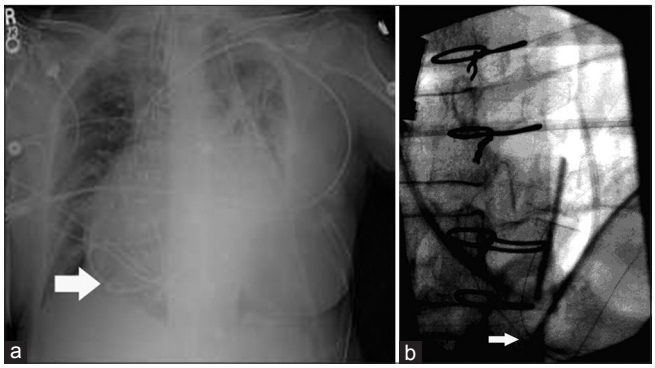

Figure 2: (a) X-ray chest arrow shows knot of the pulmonary artery catheter in RV. (b) X-ray of the knotted pulmonary artery catheter arrow shows the distal end of the catheter securely snared at the balloon site and withdrawing the knotted portion of the pulmonary artery catheter through the jugular vein

DISCUSSION

Pulmonary artery catheter (PACs) provide invasive monitoring of several hemodynamic parameters that often cannot be predicted accurately from standard clinical signs and symptoms of patients. Information obtained can be used to supplement or even correct clinical observations; however, the use of PACs remains controversial due to complications associated with them.

Indications for using PACs in cardiac and noncardiac surgical patients include severe left ventricular dysfunction, severe pulmonary hypertension, septic shock, cardiogenic shock, pulmonary edema, and severe toxaemia of pregnancy.[1] Complications associated with pulmonary artery catheterization (PACs) are divided into the following categories:

1. Venous access complications, including unintentional puncture of nearby arteries such the carotid or subclavian artery, bleeding, pneumothorax, nerve lesions, and air embolism.[2-7] The use of ultrasound for insertion of the sheath has been shown to reduce all these complications.[8]
2. Pulmonary artery catheterization causes dysrhythmias such as premature ventricular and atrial beats in 70% of the cases. These usually resolve spontaneously after the catheter is advanced or withdrawn through the right ventricle. Ventricular tachycardia or fibrillation occurs in 0.3% of the cases. Catheter introduction can produce right bundle-branch block and, in patients with previous left bundle-branch block, can induce a complete heart block.
3. Complications associated with catheter residence inside the body including venous thrombosis thrombophlebitis, pulmonary embolism and infarction, cardiac mural thrombi, valvular injury, infection, and pulmonary artery rupture. Sepsis is a complication of PAC residence.
4. Those associated with misuse of equipment and misinterpretation of data.

Many complications related to PACs have been reported over the past decades. Their incidence is not clearly known as they are described either as an isolated case report or as a small case series.

All intravascular devices are at risk for knots, but PACs appear to be the most susceptible to knotting as described in our case report. Entrapment of PACs to intracardiac structures most often occurs in the right atrium.[1] PACS can be sutured into intracardiac structures during purstring suture for inserting bi-caval cannula for establishment of cardiopulmonary bypass (CPB).[1] The knot or looping formation occurs during an attempt to direct the catheter to pulmonary wedge position in back-and-forth manipulation maneuvers. These problems are more likely when the PAC is inserted to an excessive distance, leading to looping or coiling of the catheter within the cardiac chambers. In such an event, the catheter should be carefully withdrawn to the 30 cm mark and re-advanced, avoiding careless maneuvers. Knots or kinks in the catheter should be suspected if there is any difficulty in withdrawing a PAC, and the diagnosis may be confirmed by TOE or chest radiography. Another recommendation is to inflate the PAC balloon partially when it is located in the vena cava. Only after it reaches the right ventricle should it be completely inflated. This maneuver can facilitate the progression of the PAC tip to the pulmonary artery without producing cardiac valve lesions and can also reduce the possibility of PAC looping. The literature reviewed suggests a variety of techniques for managing fixed or knotted intravascular catheters, but all have associated risk.[9] There are surgical and nonsurgical techniques for solving this problem. In general surgery cases, one option is to reduce the knot's diameter by introducing another sheath to tie the knot more firmly,

pull it back to the skin, and then surgically remove it.[10] Other techniques are simple traction, extraction using a large sheath or guide wires, cut-down techniques, removal via snare under fluoroscopy, and open surgery.[10] In cardiac surgery, a knotted intracardiac catheter can be removed via cardiotomy.[11] In our case, the patient had very poor left ventricular function and was undergoing off-pump coronary myocardial revascularization. Interventional radiological techniques, such as the one used in our case, have for the most part replaced open surgical techniques. The best and the least invasive option is the use of a 0.038-inch movable core-guided wire through the lumen of the catheter to untie the knot under fluoroscopic control.[10] Fluoroscopic control is necessary because of the theoretical hazard of perforating the catheter, blood vessels, or cardiac chambers. If the knot is not too tight, this technique should not introduce an extra hazard to the patient.[10]

In summary, the literature reveals that PACs provide useful hemodynamic information for the management of patients. However, one should always bear in mind the risk of complications. Prior to termination of CPB, the PACs ought to be pulled gently 5-10 cm to ensure that it is free. Angulation of the catheter is an important diagnostic sign.[1]

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