Case Report

Pulmonary artery catheter knotting in a coronary artery bypass surgery patient

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Abstract

A fifty seven years old female patient came to operating room for coronary artery bypass grafting (CABG) surgery. After induction, invasive monitoring lines were placed. Pulmonary artery catheter (PAC) floated after three attempts and it was wedged at 60cm. Intra operative course was smooth and patient transferred to cardiac intensive care unit (CICU). First chest X-ray revealed PAC knotting in the right ventricle. Vascular surgeon was involved and he removed it through right internal jugular vein under fluoroscopic guidance. Pulmonary arterial catheterization is an invasive procedure. Knotting usually occurs due to excessive advancement of the pulmonary artery catheter beyond the normally expected distance. The removal of a catheter should never be forced when resistance is encountered. PA catheter knotting is a rare complication but it should be suspected whenever there is excessive length of catheter required to reach pulmonary artery.

Introduction

Pulmonary artery catheter or Swan-Ganz catheter is a flow-directed balloon-tipped catheter, which is in clinical use for more than 30 years. Although pulmonary artery (PA) catheterization was first performed in the mid 1940s under fluoroscopic guidance but the introduction of distal tip balloon floatation by Ganz in 1960, made it possible to use PA catheter in clinical situation.[1] Initially PACs were used almost exclusively for diagnostic purposes in catheterization laboratories to identify potential cardiac surgical cases. In 1971 Swan and colleagues introduced the first commercially available balloon-tipped catheter that could be inserted at the bedside for assessment of cardiac pump function.[1]

Case Report

A fifty seven years old female patient weighing 65 kg, who presented in preoperative clinic with history of high blood pressure and ischaemic changes on electrocardiogram (ECG), was scheduled for coronary artery bypass grafting (CABG) after cardiac assessment. Her comorbids included hypertension, diabetes mellitus and renal dysfunction. She was on atenolol, amlodipine, gliclizide and aspirin.

Her laboratory investigations showed haemoglobin of 11 gm/dl, platelet count of 224,000/dl, white blood cell count of 10,600/dl, serum Na 126meq/l, K 3.9 meq/l, Cl 99 meq/l and HCO3 17.7 meq/l. Her chest X-ray revealed left ventricular hypertrophy, while ECG showed ST segment changes in inferior leads. Transthoracic echocardiography showed left ventricular hypertrophy, ejection fraction of 60% and left atrial dilatation with mitral regurgitation (MR). Angiography revealed three vessel coronary artery disease with right coronary artery 100% occluded, left anterior descending artery and left circumflex artery was 50% occluded .

In the operating room, standard monitors were applied and a 16 gauge intravenous cannula inserted. Monitors included five lead ECG, non-invasive blood pressure and pulse oximeter. Arterial line was inserted after 50 microgram of Injection fentanyl. The patient was preoxygenated and induced with fentanyl, etomidate and rocuronium bromide. Patient remained haemodynamically stable during induction. Right internal jugular vein was accessed without difficulty for Swan-Ganz sheath introduction. PA catheter was introduced through the sheath and balloon inflated at 20 cm mark with 1.5 cc of air. While looking at the PA tracing on the monitor, catheter was pushed in. Initial attempts to place PA catheter tip in a wedge position were unsuccessful. We were able to float the catheter to the correct position on third attempt and the catheter length achieved at wedge position was 60 cm (PA pressures 35/15). Anaesthesia was maintained with isoflurane (1-3%) and increments of pancuronium and

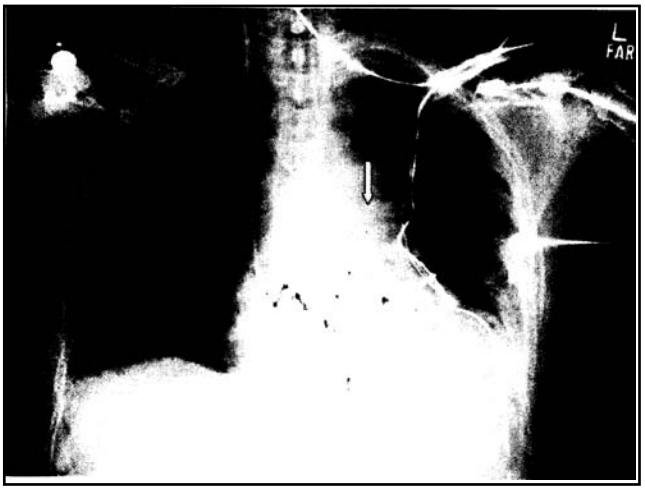

Figure. Pulmonary artery catheter knot in the right ventricle.

fentanyl.

Cardiopulmonary bypass (CPB) course was uneventful and patient came off CPB after fulfilling the set criteria with inotropic support of epinephrine 0.05 micro gram/kg/min. Total bypass and cross clamp time was 95 minutes and 54 minutes respectively. At the end of surgery, patient was shifted to cardiac intensive care unit (CICU).

In the CICU, patient was mechanically ventilated and laboratory investigation and chest X- ray (CXR) was done. CXR revealed knotting of PA catheter in the right ventricle while the distal limb was in the right pulmonary artery shown in Figure. Vascular surgeon was involved at this stage and a decision to remove PA catheter in the operating room was taken. After gaining surgical exposure of the venepuncture site, a purse-string of Prolene 4/0 suture was placed around it. The patient was placed in the Trendelenburg position, the knotted catheter withdrawn, while the purse-string suture was immediately tightened avoiding uncontrollable haemorrhage or massive air embolism. Patient remained stable and was extubated the following day.

Discussion

Pulmonary arterial catheterization is an invasive procedure. It requires the insertion of a central venous port and passage of a catheter across two heart valves. Several complications can occur during central venous access, PA catheter insertion and maintenance of PA for monitoring. Inflation of the catheter once in a PA may cause rupture of that vessel with disastrous consequences. Continual presence of a PAC increases the likelihood of catheter-related bloodstream infections and endocarditis. The recently published PAC-Man[2] (Pulmonary Artery Catheters in patients Management in Intensive Care) and ESCAPE (Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheter Effectiveness) randomized clinical trials identified incidences of complications of 10% and 5%, respectively, in patients in whom PAC insertion was attempted. The most common complications in PAC-Man study were site haematoma (4%), arterial puncture (3%), and arrhythmias needing treatment (3%) with one cardiac arrest. In ESCAPE, PAC related infections occurred in 2.5%, catheter knotting and pulmonary infarction or haemorrhage 1% and ventricular arrhythmia 0.5 %.[3]

At a major European heart center[4], 3730 Swan-Ganz catheter placements were done for cardiac surgery. They observed four serious complications related to Swan-Ganz catheterization and placement (0.1%): one right ventricular free wall perforation, one knotting and two pulmonary artery ruptures.

The knotting of the catheter is a rare complication[5] and it should be anticipated if there is an excessive advancement of the pulmonary artery catheter beyond the normally expected distance.[5] Knotting of the pulmonary artery catheter can occur within the vascular space or around cardiac structures.[6,7] Repeated insertions would make the catheter softer and liable to knot. Knotting is more common with small-bore flotation catheters.[8] Kinking and looping, which are the precursors of knotting, occur when an excessive length of catheter is inserted. After a right ventricular pressure tracing has appeared during insertion, not more than 10 to 15 cm of catheter should be required to obtain pulmonary artery pressure tracing. Dilated heart chambers and repeated catheter manipulation, especially without fluoroscopy, are predisposing factors.[9] Therefore, coiling should be suspected whenever a wedge pressure tracing is observed at a catheter insertion of greater than 50 cm through the right internal jugular vein. In the case described in this report, the knotting was not anticipated because it was thought that the enlarged right ventricle accommodated a longer length of the catheter and this could explain why the catheter was inserted to a length of 60 cm. Nevertheless, it is not unusual for patients with right heart failure or tall patients to require an insertion length of greater than 50 cm. The possibility of knot formation must be considered whenever resistance is met on withdrawal of an intravascular catheter. Such resistance was encountered in our patient on withdrawal of the catheter. The removal of a catheter should never be forced when resistance is encountered. Forced removal may cause avulsion of the tricuspid valve, papillary muscle, and chordae tendini or catheter embolism.[9] Different methods were reported to check for knot formation of the Swan-Ganz catheter. These include use of fluoroscopy, chest x-ray, and transoesophageal echocardiography.

Knotting of the Swan-Ganz catheter can be minimized by using larger gauge catheters, injection of 10 to 20 mL of cold solutions into the catheter during insertion to make it stiffer, full inflation of the balloon in a large central vein before advancing the catheter to the right atrium and the use of fluoroscopy in patients with dilated cardiac chambers.[9] It has been suggested that if a knot is discovered, the use of a guide wire might be of value if the knot is not tight.[10] This method of removal is done through right heart catheterization using guide wire introduced through femoral vein under fluoroscopic guidance. After unknotting the PAC by the guide wire, catheter could be removed through actual venepunture site under fluoroscopic guidance.[10]

Conclusion

PA catheter knotting is a rare complication but it should be suspected whenever there is excessive length of catheter required to reach pulmonary artery and daily X-rays should be done to reach early diagnosis.

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