Detection of Pulmonary Artery Catheter Knotting by Transesophageal Echocardiography

- A Case Report -

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Placement of a pulmonary artery catheter is associated with various complications, including catheter knotting. Fluoroscopy can be used to visualize and confirm catheter knotting. Transesophageal echocardiography is readily available to detect knot formation in the operating room or intensive care unit. We present a case in which pulmonary artery catheter knotting was detected by transesophageal echocardiography. This method may be useful in the operating room or in the intensive care unit to identify the presence and location of catheter knotting.

Key Words: catheter knotting, pulmonary artery catheter, transesophageal echocardiography.

The flow-directed balloon-tipped pulmonary artery (PA) catheter was introduced by Swan and colleagues¹⁾ in 1970. It is an important hemodynamic monitoring tool in cardiac surgery and critical care. Unfortunately, several complications can occur following its use; complications have been reported in up to 24% of cases.²⁾ Knotting of a PA catheter is a rare complication that may lead to serious adverse outcomes such as rupture of the chordae of the tricuspid valve. We report a case of a knotted PA catheter that was detected by transesophageal echocardiography (TEE) and removed surgically.

CASE REPORT

A 38-year-old man presented with complaints of severe persistent substernal pain. He reported mild chest pain with exertion for 2–3 years. Coronary angiography showed complete occlusion of the proximal left anterior descending artery. We observed occlusion in 60% of the proximal left circumflex artery and 90% of the distal left circumflex artery. Emergency

coronary artery bypass graft (CABG) was scheduled.

After induction of general anesthesia, the right radial artery was cannulated for continuous blood pressure monitoring, and a PA catheter (Swan-Ganz CCOMbo V [7.5 Fr], Edwards, USA) was inserted through a percutaneous sheath introducer (AVA 3Xi [8.5 Fr], Edwards, USA) into the right internal jugular vein. Pressure monitoring of the distal catheter port showed the progress of the catheter to the right ventricle. The catheter failed to advance from the right ventricle to the pulmonary artery. Several attempts to introduce the catheter to the pulmonary artery were unsuccessful. On attempting to remove the PA catheter, unusual resistance was met before the last 35-cm length of the catheter was withdrawn. Firm traction was not applied. TEE was performed promptly to detect any problem associated with the PA catheter. TEE revealed that the PA catheter was coiled around the tricuspid valve (Fig. 1A), and a catheter knot was seen in the right ventricle (Fig. 1B). We discussed methods to remove the catheter, and decided to remove the knot through a small right atrium incision under cardiopulmonary bypass. When the right atrium was opened, the catheter was found loosely knotted around a posterior chordae tendineae of the right ventricle. The surgeon cut the catheter and removed the knot successfully. The CABG was performed uneventfully, and the patient had no other PA catheter-related complications.

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Fig. 1. The arrows point to the pulmonary artery catheter (A) and catheter knotting point (B). In the midesophageal 4-chamber view (A), the PA catheter image appears as 2 parallel white lines in the right atrium. Forty degrees from the midesophageal 4-chamber view (B), the white arrow represents the knotting point of the PA catheter in the right ventricle adjacent to the tricuspid valve.

DISCUSSION

The incidence of complications associated with the use of pulmonary artery catheterization is 3–17%.³⁾ Some of the complications associated with PA catheters are those related to vascular access such as pneumothorax, hemothorax, or damage to the vessel or associated structure, and those related to catheter placement such as dysrhythmias, endocarditis, catheter coiling or knotting, valvular damage, pulmonary artery rupture, pulmonary artery thrombosis and infarction, and thrombocytopenia.^{4,5)} Rare intracardiac knotting of the PA catheter is a serious complication associated with catheter insertion. Knot formation is usually detected by radiography, but a chest radiograph is not always available in the operating room or intensive care unit. Transesophageal echocardiography (TEE) may be a good method to detect PA catheter knotting.⁶⁻⁸⁾ TEE provides fast and real-time detection of PA catheter-related complications. Moreover, it avoids exposure to unnecessary radiation and allows bedside intervention. In this case, when resistance was felt at withdrawal of the PA catheter, TEE was immediately performed to identify the problem. The knotted catheter was detected around the tricuspid valve. If we had not recognized intracardiac knotting and had attempted to withdraw the catheter aggressively, the chordae tendineae might have ruptured, thereby causing severe tricuspid valve regurgitation.

Risk factors that increase the likelihood of catheter knotting are blind introduction, small catheter diameter, incomplete balloon inflation before advancement, multiple wedge attempts, catheter bending secondary to heat, and enlarged right heart chambers.⁹⁾ Repeated attempts to advance a catheter over an estimated distance to obtain a pulmonary artery waveform can

cause a catheter to coil, and may result in catheter knotting. This can be avoided by continuous visualization of catheter insertion by using fluoroscopy or TEE.^{9,10)}

There are several methods to remove knotting catheters such as direct extraction with a larger sheath, the guide wire method, cut-down technique, percutaneous fluoroscopic removal, and open surgery. In our case, the knotted catheter was detected during cardiac surgery, so it was removed surgically.

In the operating room or intensive care unit, TEE is a useful device to examine PA catheter location and diagnose coiling or knotting.

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