

Video fluoroscopy for pulmonary artery catheter insertion in high-risk situation of knotting or misplacement

Z. LTAIEF¹, S.D. QANADLI^{2,3}, P. ECKERT^{1,3}, N. BEN-HAMOUDA^{1,3}

¹Department of Adult Intensive Care Medicine, Lausanne University Hospital (CHUV), Lausanne, Switzerland

²Department of Radiodiagnostic and Interventional Radiology, Lausanne University Hospital (CHUV), Lausanne, Switzerland.

³Faculty of Biology and Medicine, University of Lausanne (UNIL), Lausanne, Switzerland

LINK PER VIDEO <https://www.youtube.com/watch?v=jnMnE9ThcCU>

Abstract. – Pulmonary artery catheter (PAC) insertion in patients with severe pulmonary hypertension, right heart dilation and failure, is very challenging. Misplacement and knotting are rare but could be serious complications leading to a delay of the monitoring and sometimes an emergent not expected intervention. Here we report a case of a patient admitted to Intensive Care Unit (ICU) with an acute hypoxemic respiratory failure. She had a history of chronic respiratory failure with pulmonary hypertension and right heart failure. We decided to monitor her cardiac output and pulmonary pressure with a PAC. Repeated attempts to reach the pulmonary artery (PA) were unsuccessful and the PAC was knotted and blocked at the distal tip of the introducer. Under fluoroscopy the knot was released by radiologist. Few days later, a monitoring of PA pressure was needed to guide a PA vasodilator treatment. Under fluoroscopic guidance with the supervision of radiologist, the catheter was successfully placed in the PA at the first attempt. Despite some limitations (patient displacement and radiation), this technique is more accurate than waveform guidance. We suggest in specific situations (low cardiac output, severe pulmonary hypertension, and severe tricuspid regurgitation) to consider first fluoroscopy.

Key Words:

Pulmonary artery catheter, Pulmonary hypertension, Right ventricular failure.

Case Presentation

A woman in her 30's was admitted to ICU with hypoxemic respiratory failure secondary to a hospital-acquired pneumonia. She had a his-

tory of multi-resistant tuberculosis, a left pneumonectomy, and recurrent pulmonary infections. She had developed a progressive, chronic respiratory failure (home oxygen therapy 6-8 l/mn) with pulmonary hypertension class III. Transthoracic echocardiography revealed acute right heart failure with severe dilatation of right ventricle, severe tricuspid regurgitation and increased pulmonary artery (PA) pressure (100/45 mmHg). We decided to monitor her cardiac output and pulmonary pressure with a pulmonary artery catheter (PAC). A 9-F sheath introducer was successfully placed in the right internal jugular vein under ultrasound guidance. An 8-F Swan-Ganz catheter (Edwards Lifesciences, Irvine, CA, USA) was inserted, and the balloon inflated at a depth of 20 cm. The catheter was advanced with pressure wave observation. However, repeated attempts to reach the PA were unsuccessful despite appropriate right atrial and ventricular waveforms. During the final attempt, the PAC catheter was advanced without acquiring a pulmonary artery waveform. During withdrawal, the catheter became caught at a depth of approximately 25 cm. Further attempts at withdrawal beyond this point were unsuccessful. A bedside chest x-ray revealed a knotted PAC blocked at the distal tip of the introducer (Figure 1). Under fluoroscopy the knot was released using a snare technique from a right common femoral vein access and the catheter removed without complications (Video 1). A few days later, the clinical situation deteriorated, and we decided to start a PA vasodilator under PA pressure monitoring. Given the difficulties with

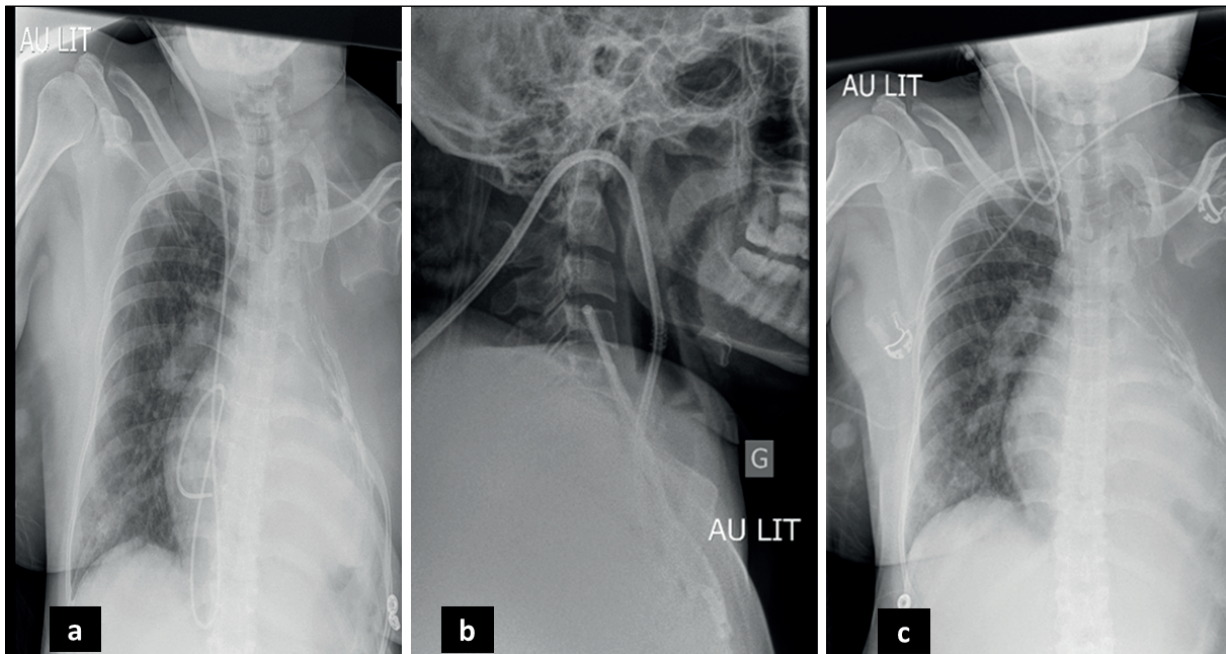


Figure 1. Portable chest X-ray showing unsuccessful attempts of pulmonary artery catheter (PAC) insertion. **a:** Posteroanterior view of a knotting PAC, **b:** Lateral view of a knotting PAC, **c:** Last attempt of insertion with a knotting and blocked PAC (posteroanterior view).

previous attempts at PAC insertion, we chose to insert the PAC under fluoroscopic-guidance with the supervision of radiologist. The catheter was successfully placed in the PA (Figure 2) without complications.

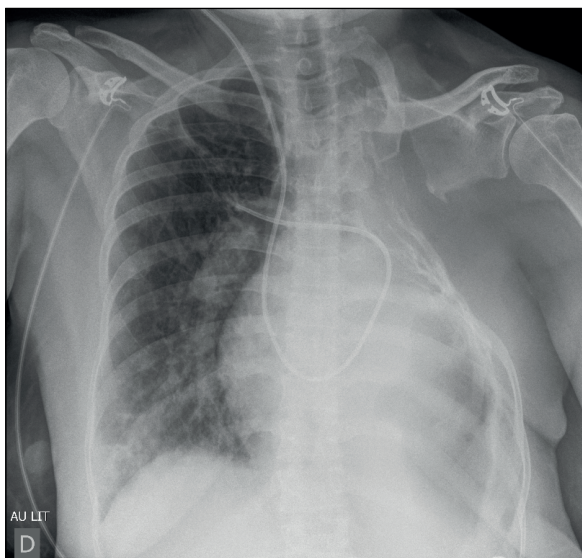


Figure 2. Chest X-ray demonstrating the normal position of the PAC tip in the right pulmonary artery. This PAC was inserted under fluoroscopic-guidance and the radiologist supervision.

Discussion

Despite decrease of the use of PAC over the last decade¹, it remains a useful monitoring tool in some complicated hemodynamic cases in ICU. PAC related complications can occur in 10% of the cases². Misplacement and knotting are rare (<1%), but there could be serious complications leading to an emergent intervention².

Here, the PAC was knotted in the superior vena cava and video-fluoroscopy (VF) was used initially to remove knotted catheter with experimented radiologist and then to guide the new catheter placement. In cardiac surgery, Weinberg et al³ showed that PAC insertion under VF is a safe method, which facilitates positioning with less time, fewer attempts to insertion and it results in a significant decrease in rate of complications (16 vs. 52%). VF provides real-time follow up of catheter progression, which allows early recognition of aberrant path or excessive insertion avoiding misplacement and knotting. Radiation and the need to move the patient to radiology are the most limitations of VF. Other authors suggest using transesophageal echography (TEE) to guide insertion and to decrease complications^{4,5}, which is non-radiating and available at the bedside. Despite that TEE guiding results in higher

success rate (final localization in the proximal right PA) compared to pressure wave technique, there was no difference in the time to successful insertion⁵. Moreover, the balloon floating (more than current of blood flow) is the main factor of catheter advancement in non-pulsatile experimental system⁶. There are no established criteria for difficult PAC insertion. Otherwise, numerous publications of clinical cases report more difficulties in performing PAC insertion in situation of decreased flow. However, Cronin et al⁵ suggest ventricular dysfunction, low cardiac output (cardiac index <1.5 L/min/m²), severe pulmonary hypertension (mean PA pressure >40 mmHg), and severe tricuspid regurgitation as at high risk of failure insertion. In our report the patient met, unfortunately, all the risk factors.

Conclusions

Ventricular dysfunction, low cardiac output, severe pulmonary hypertension, and severe tricuspid regurgitation are high-risk situations of PAC misplacement. We suggest in such specific situations to consider VF. This tool is still the most accurate and its great efficacy should outweigh limitations.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Competing Interests

Authors have nothing to disclose with regard to commercial support.

Funding

No funding was provided for this article.

ORCID

Zied Ltaief ORCID 0000-0003-4428-5223

Authors' Contribution

ZL, SDQ, PE, NBH equally contributed to the conception and design of the paper and its figures. ZL and NBH, drafted the manuscript. All authors critically revised the manuscript.

References

- 1) DE BACKER D, VINCENT JL. The pulmonary artery catheter: is it still alive? *Curr Opin Crit Care* 2018; 24: 204-208.
- 2) NATIONAL HEART, LUNG, AND BLOOD INSTITUTE ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS) CLINICAL TRIALS NETWORK, WHEELER AP, BERNARD GR, THOMPSON BT, SCHOENFELD D, WIEDEMANN HP, DEBOISBLANC B, CONNORS AF, HITE RD, HARABIN AL. Pulmonary-artery versus central venous catheter to guide treatment of acute lung injury. *N Engl J Med* 2006; 354: 2213-2224.
- 3) WEINBERG L, MILES LF, ALLAF M, PILLAI P, PEYTON P, DOOLAN L. Video fluoroscopy for positioning of pulmonary artery catheters in patients undergoing cardiac surgery. *J Cardiothorac Vasc Anesth* 2015; 29: 1511-1516.
- 4) BAER J, WYATT MM, KREISLER KR. Utilizing transeophageal echocardiography for placement of pulmonary artery catheters. *Echocardiography* 2018; 35: 467-473.
- 5) CRONIN B, KOLOTINIUK N, YOUSSEFZADEH K, NEWHOUSE B, SCHMIDT U, O'BRIEN EO, MAUS T. Pulmonary artery catheter placement aided by transesophageal echocardiography versus pressure waveform transduction. *J Cardiothorac Vasc Anesth* 2018; 32: 2578-2582.
- 6) PARLOW JL, MILNE B, CERVENKO FW. Balloon flotation is more important than flow direction in determining the position of flow-directed pulmonary artery catheters. *J Cardiothorac Vasc Anesth* 1992; 6: 20-23.