
Clinical Reports

Catheter-induced pulmonary artery perforation associated with an unusual wedge pressure tracing

Olli S. Takkunen MD, Eija A. Kalso MD

Pulmonary artery perforation is one of the most serious complications of pulmonary artery catheterization. We report a case of a pulmonary artery perforation which occurred during the placement of a Swan-Ganz catheter in a patient with mitral valve regurgitation. During the insertion of the catheter a deep negative pressure wave was seen in the pulmonary artery tracing, with concomitant haemoptysis. The postoperative chest radiograph revealed an infiltration distal to the tip of the pulmonary artery catheter. This type of unusual capillary wedge pressure tracing during pulmonary artery catheterization has not previously been reported.

The perforation of a pulmonary artery with a Swan-Ganz catheter is a serious and sometimes lethal complication of invasive haemodynamic monitoring. The clinical signs of pulmonary artery perforation may vary from minor haemoptysis to hypotension and hypovolemic shock. Many cases of distal pulmonary artery rupture go unnoticed or may be diagnosed as pulmonary infarction.¹ During the insertion of a pulmonary artery catheter, a damping, flattening and abruptly rising wave form may be seen as an immediate sign of improper location of the pulmonary artery catheter.²⁻⁴ This trace form may result from the impingement of the catheter against the vessel wall or from the herniation of the balloon over the catheter

tip.^{2,4} We report a case in which a deep negative wave form in the pulmonary artery tracing was associated with coughing and haemoptysis during the insertion of the catheter.

Case report

A 67-year-old woman with a previous history of a closed mitral commissurotomy 13 years earlier was admitted for surgery with a diagnosis of mitral valve regurgitation and a critical narrowing of the left anterior descending coronary artery. The diagnoses had been confirmed with left ventricular cineangiography and coronary angiography. Preoperative examination also showed congestion of the pulmonary veins. The width of the heart was $660 \text{ ml} \cdot \text{m}^{-2}$ body surface and the left atrium was very prominent. Preoperative medication included a peroral anticoagulant. The thromboplastin time (Sinplastin®-A) was 0.22 three days before operation, when the anticoagulant therapy was discontinued.

Prior to the induction of anaesthesia, a Swan-Ganz thermodilution catheter (model 93A-131H-7F, American Edwards Laboratories) was passed into the pulmonary artery via the right internal jugular vein under continuous electrocardiographic and pressure monitoring.^{5,6} Pressures from the left radial artery and from the tip of the pulmonary artery catheter were continuously recorded (thermal array recorder, Nihon Kohden Corporation). During the pulmonary artery catheterization it was difficult to obtain a capillary wedge position. When the catheter, with the balloon inflated with 1.5 ml of air was passed forwards, to a distance of 65 cm, a deep negative wave form was seen on the monitor (Figure 1) and at the same time the patient coughed. The catheter was withdrawn. Two subsequent attempts to obtain a pulmonary wedge tracing had the same outcome. Thereafter the catheter was drawn back to 48 cm and no further attempts to obtain a wedge tracing were made. In this position the

Key words

EQUIPMENT, CATHETERS: pulmonary arteries;
MONITORING, VASCULAR: pulmonary artery catheters;
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From the Department of Anaesthesia, Helsinki University Central Hospital, SF-00290 Helsinki, Finland, where correspondence should be addressed to Dr. Olli S. Takkunen.

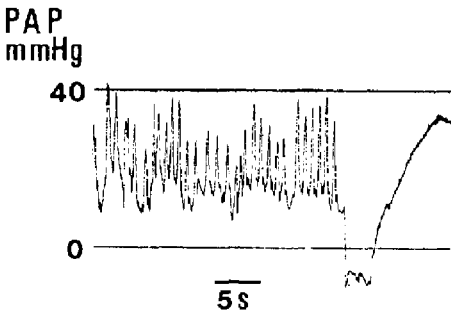


FIGURE 1 Pulmonary artery pressure tracing recorded with the speed of $2.5 \text{ mm} \cdot \text{sec}^{-1}$ during the insertion of a Swan-Ganz catheter in a patient with mitral valve regurgitation. Note the deep negative pressure wave followed by the "overwedge" pattern.

pulmonary artery pressure was 38/17 mmHg, and the pulmonary artery tracing persisted until cardiopulmonary bypass.

After catheterization, when the drapes were removed, dark blood was visible in the left nostril and in the mouth of the patient. The total amount of blood aspirated from the mouth was about 30 ml. Anaesthesia was induced with diazepam, pancuronium and high-dose fentanyl. The induction of anaesthesia was uneventful except for a 10 min period of hypotension (systolic arterial pressure 80–95 mmHg) with a concomitant decrease in the pulmonary artery pressure (32/13 mmHg). The hypotension was thought to be due to hypovolemia and was treated with fluid loading (1000 ml of lactated Ringer's solution in 75 min) and a dopamine infusion. After intubation a high airway pressure was noted during manual ventilation. Endotracheal suction twice produced about 20 ml of dark blood. The planned operation, mitral valve replacement and single coronary artery bypass, was conducted uneventfully. During cardiopulmonary bypass no endotracheal bleeding was seen. After cardiopulmonary bypass only a small amount of dark blood was suctioned from the endotracheal tube and the pulmonary artery tracing returned spontaneously. No attempts to obtain a wedge position were made.

The first postoperative chest radiograph revealed an infiltration of about $7 \times 8 \text{ cm}$ distal to the tip of the pulmonary artery catheter. The infiltration was not present preoperatively and it was resolving radiologically after two days. The postoperative course of the patient was prolonged because of pulmonary congestion and dizziness. No bleeding from the airways occurred. The patient was discharged in good condition on the 26th postoperative day.

Discussion

Since the introduction of balloon flotation pulmonary artery catheters in 1970,⁷ increasing numbers of catheter-induced pulmonary artery perforations have been described. The incidence of this serious complication varies between 0.06–2.0 per cent in different patient series.^{3,8–11} On the other hand, mortality is high, 45–53 per cent.^{12–14} Over one-third of all cases have occurred in cardiac surgical patients.¹³ Other factors associated with catheter-induced pulmonary artery perforation are pulmonary hypertension,^{4,12–16} advanced age,^{1,8,13,14,16} and anticoagulation.^{13,17} This complication is more common in women than in men.^{13,14} In the present report, the patient had all of the above contributing factors.

In this patient, the final diagnosis of a pulmonary artery rupture remains without confirmation. However, taking all the clinical aspects into consideration, the diagnosis of catheter-induced pulmonary artery perforation is most likely. Haemoptysis or bleeding from the endotracheal tube has been reported to be the most frequent sign of a catheter-induced pulmonary artery perforation.^{13,14,16,18,19} In our patient, the bleeding was observed to come from the trachea. Unfortunately bronchoscopy was not performed. The postoperative radiographic infiltrate in the right lower lobe could also have been a pulmonary infarction, induced by a prolonged wedge position of the Swan-Ganz catheter. The pulmonary catheter was, however, drawn back to 48 cm immediately after the failed attempts to obtain a wedge position. Before and immediately after cardiopulmonary bypass the pulmonary artery tracing was clearly visible. The more probable reason for the infiltration was intrapulmonary haemorrhage.

Different mechanisms have been reported to cause pulmonary artery perforation.⁴ First, the balloon can disrupt the pulmonary artery. Second, eccentric or distorted inflation of the balloon can cause the tip of the catheter to be propelled through the vessel wall. Third, the catheter tip can be advanced too far distally and perforate the vessel wall. In our case, it was difficult to obtain a pulmonary capillary wedge tracing, and the catheter was advanced up to 65 cm, at which time the haemoptysis began. Obviously, because of the "giant V-valve" due to mitral valve regurgitation a capillary wedge tracing was not correctly recognized and the catheter was inserted too far. This kind of difficulty occurs in patients with pulmonary hypertension.¹⁶ In a review by Shah *et al.*⁹ inability to recognize wedge tracing in patients with mitral valve regurgitation was present in 66 of 373 patients. In the present case, haemoptysis began when the pulmonary catheter was passed forward with the balloon inflated. The balloon likely distended and tore the wall of the pulmonary artery, thus creating an airway communication. Most probably, anticoagulation

and increased precapillary pressure contributed to the bleeding.

During pulmonary artery catheterization the pulmonary capillary wedge tracing is obtained with concomitant pressure monitoring. The typical phasic wedge contour is, however, not always obtained. An "overwedged pattern" with dampening, flattening, and abruptly rising wave form has been described.²⁻⁴ It has been attributed to the impingement of the catheter against the vessel wall or herniation of the balloon over the catheter tip.^{2,4} In the case report by Haapaniemi *et al.*³ the overwedged tracing was followed within seconds by haemoptysis. In the present case, an overwedged pattern was preceded by a deep negative phase in the tracing. This kind of tracing has not been reported during pulmonary artery catheterization. A probable explanation for the appearance of a negative wave form is the reflection of the negative intrapleural pressure in the alveoli and the parenchyma surrounding the pulmonary artery.²⁰ The negative pressure tracing which occurred in our patient was not due to coughing. This is demonstrated in Figure 2, where a wedge tracing was recorded in another patient during two episodes of coughing.

We conclude that extra care should be taken when inserting a pulmonary artery catheter into a patient with mitral valve regurgitation. The catheter should not be passed further than 60 cm, even if the wedge position is not achieved.²¹ The prominent V-wave often disturbs the recognition of the normal pulmonary artery tracing. A perforation of the pulmonary artery must be suspected if a negative pulmonary artery tracing occurs and the patient coughs during the catheterization. In our case the operation was conducted successfully. However, according to most authorities the operation should be cancelled if a pulmonary artery perforation is detected before the beginning of the operation.^{4,8,11}

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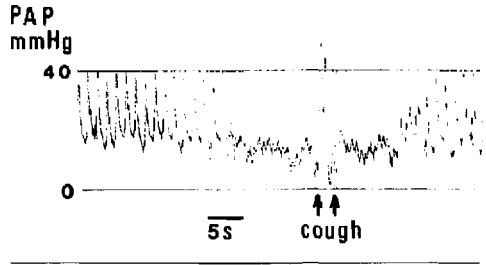


FIGURE 2 Pulmonary artery wedge pressure tracing of another patient recorded with the speed of 2.5 mm·sec⁻¹ during two episodes of coughing.

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Résumé

La rupture de l'artère pulmonaire est une des complications les plus sérieuses de la cathétérisation de l'artère pulmonaire. On rapporte un cas de rupture de l'artère pulmonaire suite à la mise en place d'un cathéter de Swan-Ganz chez un patient présentant une régurgitation de sa valve mitrale. Lors de l'insertion du cathéter une onde de pression négative était observée dans le tracé de l'artère pulmonaire suivie d'une hémoptysie. Le rayon-X post-opératoire a révélé une infiltration distale au bout du cathéter de l'artère pulmonaire. Un tel tracé inhabituel de la pression de l'artère pulmonaire bloquée lors de la cathétérisation n'a jamais été rapporté dans le passé.