

Pulmonary artery dissection induced by a Swan-Ganz catheter¹

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A 70-year-old woman died after coronary artery bypass graft surgery. Autopsy revealed bilateral, massive, intrapulmonary hemorrhage secondary to pulmonary artery dissection induced by a Swan-Ganz catheter. Cystic medionecrosis of the pulmonary arteries was also identified. Catheter-induced pulmonary artery trauma is associated with a high mortality. Hemoptysis is the usual presenting sign. Great caution should be exercised when using Swan-Ganz catheters in elderly patients with known pulmonary hypertension, particularly in the setting of cardiac surgery or anticoagulation.

Index terms: Case reports • Heart catheterization, adverse effects • Pulmonary artery, injuries

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Since their introduction in 1970,¹ millions of balloon-tipped, flow-directed pulmonary artery catheters have been inserted.² In addition to their use in the cardiovascular laboratory, the hemo-

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dynamic data they provide have made them indispensable for the bedside management of the critically ill and for the intraoperative management of patients undergoing major surgical procedures.

We present what we believe to be the first case of pulmonary artery dissection resulting from the intraoperative use of a balloon-tipped, flow-directed pulmonary artery catheter, as well as a review of the literature regarding pulmonary artery injury.

Case report

A 70-year-old woman was admitted to the Cleveland Clinic because of angina pectoris at rest during a maximal medical program. (Cardiac catheterization and cinecoronary arteriographic studies performed at another institution revealed severe three-vessel coronary artery disease. Overall left ventricular performance was moderately impaired. The pulmonary artery pressure was 30/15 mm Hg.)

Complete myocardial revascularization was achieved via construction of a direct left internal mammary artery graft to the left anterior descending artery and aortocoronary saphenous vein bypass grafts to the circumflex and distal right coronary arteries. As part of the preoperative preparation in this clinical setting, a 7-F thermodilution Swan-Ganz catheter was uneventfully inserted percutaneously via the right internal jugular vein.

The patient was weaned from cardiopulmonary bypass without difficulty, but hypoxemia developed. Frothy blood was noted in the endotracheal tube. The initially excellent cardiac output and lung compliance dropped precipitously. Vasopressor agents were administered and an intraaortic

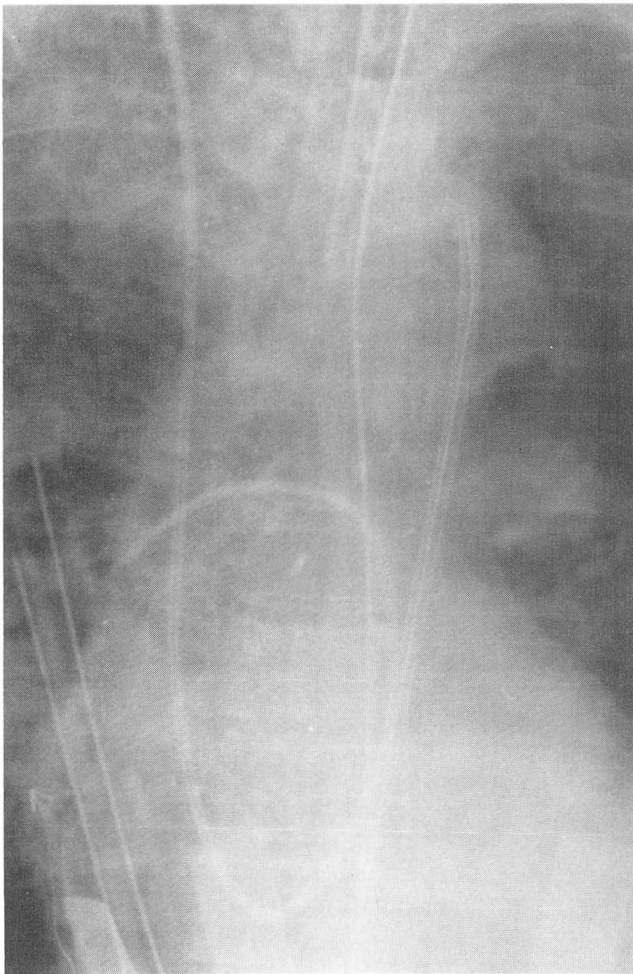


Fig. 1. Chest radiograph reveals bilateral homogeneous lung infiltrates. The tip of the Swan-Ganz catheter is located in the right main pulmonary artery.

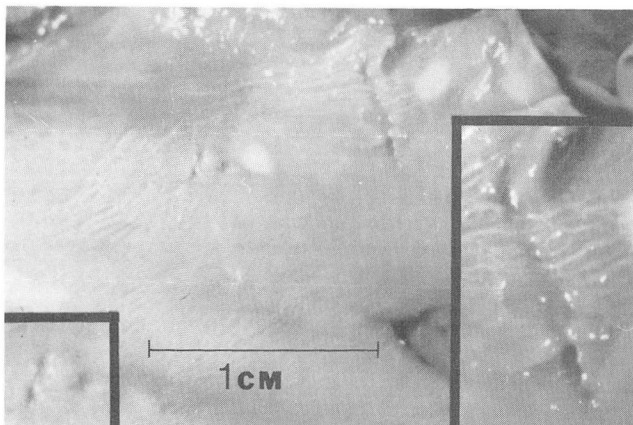


Fig. 2. Lacerations of the luminal aspect of the right main pulmonary artery. Magnifications are within the right and lower left inserts.

balloon pump was inserted in an effort to stabilize the declining hemodynamics. Because of overdistension of the lungs, the chest could not be primarily closed and the patient was transferred to the intensive care unit. A chest radiograph (*Fig. 1*) demonstrated a diffuse homogeneous infiltrate throughout the right and left lung fields. The Swan-Ganz catheter tip was located in the right main pulmonary artery. Despite vigorous supportive efforts, the patient became progressively hypoxic and hypotensive. Direct cardiac massage produced pulsatile blood flow via the endotracheal tube, and the patient subsequently died.

Autopsy findings

Autopsy examination revealed bilateral massive intrapulmonary hemorrhage. The left lung weighed 700 g (normal, 325–480 g), and the right lung weighed 700 g (normal, 360–570 g). Within the proximal 3.0 cm of the right pulmonary artery, where the Swan-Ganz catheter had been placed, were six minute lacerations ranging in size from 1.0 mm to 0.5 cm in length (*Fig. 2*). Three of the tears were transmural. Associated hemorrhage was confined to the periarterial soft tissues.

Microscopic examination of the tears in the right main pulmonary artery revealed dissection originating in the tear and cleaving the laminar elastic planes of the media. The cleavage plane extended through tissue showing moderate-to-high-grade cystic medionecrosis characterized by fragmentation of the elastic tissue lamellae and ill-defined cyst-like spaces containing colloidal iron-positive mucopolysaccharides. Sections of all lobes of the lung revealed periarterial and periarteriolar hemorrhage (*Fig. 3*), involving most of the pulmonary arterial tree and confined to the perivascular spaces. Extensive cystic medionecrosis was also found within the aorta.

The remainder of the autopsy confirmed the diagnosis of coronary atherosclerosis and the patency of the saphenous vein and internal mammary artery grafts. There was no evidence of congenital or valvular heart disease.

Discussion

We could not find any reports of catheter-induced dissection of the pulmonary artery. Spontaneous dissection of the pulmonary artery is rare. Levy³ reviewed 15 cases and emphasized the frequent association between cystic medionecrosis, pulmonary hypertension, and spontaneous dissection or rupture of the pulmonary artery.

Cystic medionecrosis of the pulmonary arteries may occur along with aortic involvement, as in

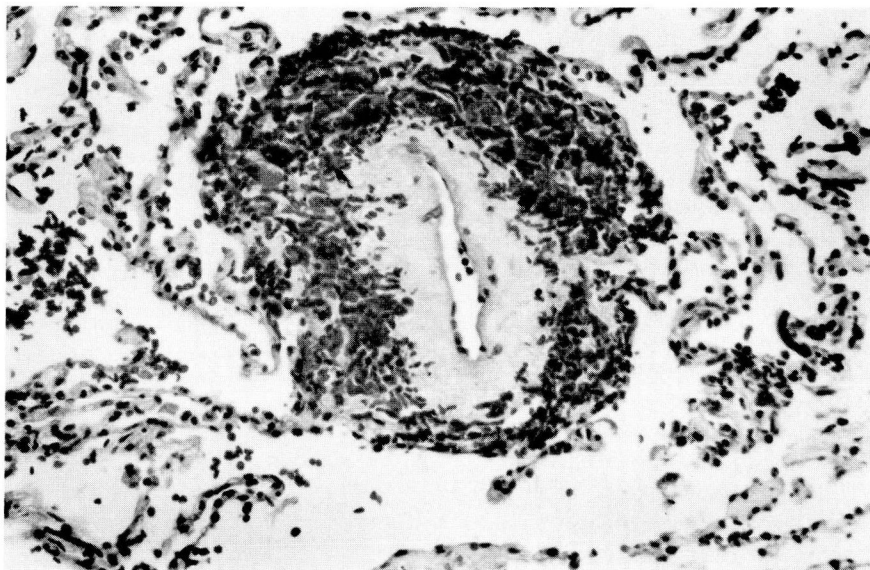


Fig. 3. Microscopic appearance of lung parenchyma. Note extensive periarterial hemorrhage. (Hematoxylin-eosin stain, $\times 150$).

Marfan's syndrome, or as a distinct lesion. Its presence without aortic involvement has been frequently associated with pulmonary hypertension, particularly as a result of ventricular septal defect, patent ductus arteriosus, and mitral valve disease.³⁻⁶ The presence of cystic medionecrosis may relate to the duration of pulmonary hypertension.⁴

Rupture of the pulmonary artery is a rare complication of Swan-Ganz catheterization. Its incidence is unclear, but has been estimated to be 0.2%.^{7,8} It has been previously correlated with balloon hyperinflation, distal catheter-tip position, advanced age, female sex, pulmonary hypertension, hypothermia, cardiopulmonary bypass, and anticoagulation.⁹⁻¹³

We have reviewed 38 reported cases of catheter-induced pulmonary artery perforations⁹⁻³⁰ (Table). Sixty percent of the patients were women

(mean age for all patients, 67.5 years). Pulmonary hypertension (defined as a systolic pulmonary artery pressure of greater than 30 mm Hg, or a statement in the case report that the pressure was elevated) was present in 25 of 32 patients (78%). In 18 of 35 patients (51%), anticoagulation had been instituted within the previous 24-hour period. Hemoptysis or endotracheal tube bleeding was a presenting sign in all but 2 patients. Pulmonary artery perforation had occurred in a setting of cardiac surgery in 37% of the patients, and 45% of both surgical and nonsurgical patients died as a result of this complication. Fifty-five percent of those who received anticoagulants died, as did 48% with pulmonary hypertension.

The high morbidity and mortality associated with catheter-induced pulmonary arterial trauma mandates an emphasis on prevention. Guidelines for the safe use of balloon-tipped, flow-directed

Table. Summary of case reports of catheter-induced pulmonary arterial trauma

Sex	Number of patients	Mean age (yrs) (range)	Increased pulmonary artery pressure	Anticoagulation	Cardiopulmonary bypass	Death
Male	15	66.8 (39-89)	10/12 (83%)	9/14 (64%)	7/15 (47%)	6/15 (40%)
Female	23	67.9 (34-90)	15/20 (75%)	9/21 (43%)	7/23 (30%)	11/23 (48%)
TOTALS	38	67.5 (34-90)	25/32 (78%)	18/35 (51%)	14/38 (37%)	17/38 (45%)

pulmonary artery catheters have been well summarized.^{2,31} Based upon the available data, we would also suggest that great caution be exercised when using this catheter in elderly patients with known or suspected pulmonary hypertension, no matter how mild, particularly in the setting of anticoagulation or cardiac surgery. Hemoptysis or endotracheal bleeding frequently precedes deterioration in these patients and should prompt a vigorous search for its cause.

Patients undergoing cardiopulmonary bypass are particularly vulnerable to catheter-induced pulmonary artery trauma. When blood is diverted away from the heart and lungs to the bypass pump, the cardiac chambers shrink and the tip of a once properly positioned catheter tends to migrate further into the pulmonary vasculature. Manipulation and retraction of the heart during the operation may force the tip of the catheter even deeper into the pulmonary artery, thereby increasing the chance of perforation.

Stone et al⁹ have suggested that the pulmonary arterial catheter be partially withdrawn into its sterile protective sleeve during cardiopulmonary bypass and subsequently reinserted when normal circulation is restored, thereby avoiding distal catheter migration. Using this prophylactic approach, they experienced no incidence of pulmonary arterial trauma in 200 consecutive patients. Though their numbers are too small to be considered significant, this method appears to be a promising means of avoiding this devastating complication during cardiac surgery.

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