

Fatal venous air embolism after removal of a central venous catheter

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Venous air embolism is an infrequent, but potentially disastrous, occurrence after the insertion or removal of central venous catheters. The authors describe fatal venous air embolism after removal of a central venous catheter in a 43-year-old man recovering from coronary artery bypass surgery. They discuss the pathophysiology, diagnosis, treatment, and prevention. Several practical considerations are necessary to prevent this complication of central venous catheterization, a procedure commonly delegated to junior house officers.

(Key words: Venous air embolism, central venous catheter)

Venous air embolism is a serious complication of central venous catheter (CVC) insertion or removal. Both medical and surgical house staff place and remove hundreds of CVCs in a single hospital in any given year. The actual incidence of air embolism is not known, because the signs and symptoms overlap those common with many cardiopulmonary events. An awareness of risk factors and attention to preventive measures are crucial to avert this potentially fatal complication. We describe an instance of fatal venous air embolism that occurred during the removal of a CVC.

Report of case

A 43-year-old man had been progressing well after undergoing coronary artery bypass surgery. On the fifth postoperative day, a right internal jugular sheath introducer (8.5 French) was removed while the patient was supine. Later, on sitting upright, the patient lost consciousness and slumped to the floor. He awakened momentarily after manual bag-valve ventilation with 100% oxygen. The patient's pulse rate was approximately 100 beats/min. During an

attempt to measure blood pressure, the patient again lost consciousness and displayed generalized seizure activity. Advanced cardiac life support was initiated, and a right CVC was placed for intravenous access. The patient rapidly progressed from bradycardia to asystole and never regained a cardiac rhythm.

The pre-cardiac arrest events were unknown to the "code team" at the onset of resuscitation efforts. Attempts at aspiration of air from the CVC late in the resuscitation sequence were unsuccessful. A chest roentgenogram taken with the patient in the left lateral decubitus position after death (*Figure*) revealed a large air-fluid level within the right side of the heart. At postmortem examination, a substantial volume of air pressure was found in the right atrium.

Discussion

Air embolism as a complication of central venous catheterization has a reported mortality of 30%.¹ Considered an uncommon event, its real incidence is not known as many instances may be attributed to other cardiac or pulmonary events. Placement of CVCs is commonly entrusted to junior house officers, and removal is often delegated to medical students often unaware of the potential for this serious complication.^{2,3}

Venous air embolus can occur whenever a large, or noncollapsible, venous channel is open to the atmosphere and a negative pressure gradient exists between the vessel opening and the right side of the heart. The pathophysiology of venous air embolism is related to the air bolus obstructing the egress of blood from the right ventricle. The resultant pulmonary hypertension and elevated right ventricular end diastolic pressure is consistent with an acute cor pulmonale. Whereas large bubbles mechanically block the pulmonary artery outflow tract, smaller bubbles may activate platelets, leading to aggregation. Stimulated platelets then release vasoactive substances that further augment pulmonary hypertension as well as lead to increased airway resistance, pulmonary edema, and myocardial ischemia.^{1,3,4} The amount

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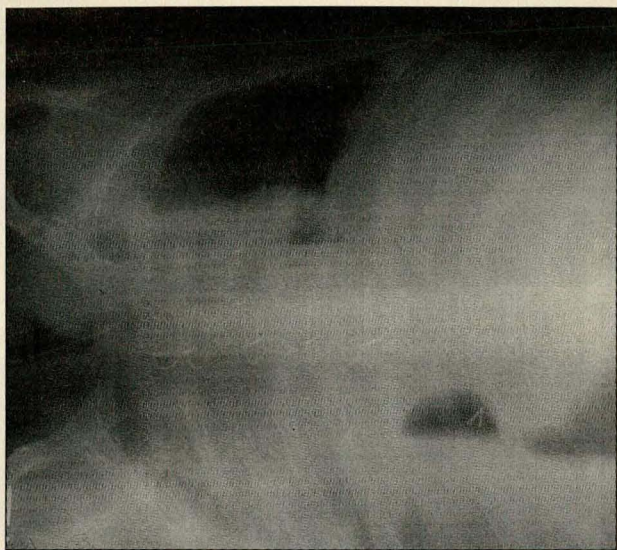


Figure. Postmortem left lateral chest roentgenogram with subject in decubitus position shows air-fluid levels within chambers of the heart.

of venous air that is fatal is estimated to be approximately 200 cc but may be dependent on flow rates and underlying cardiopulmonary status.^{1,5}

When witnessed early, signs and symptoms of venous air embolism may include tachypnea, air hunger, wheezing, and a "millwheel" murmur over the precordium. Neurologic symptoms are frequent.³ The diagnosis is difficult to document and is usually one of exclusion because many of the clinical signs and symptoms mimic those of numerous cardiac or pulmonary events (or both). As in our patient, a history of recent pre-event circumstances is extremely important. In patients who can be stabilized, two-dimensional M-mode echocardiography have proved to be a useful diagnostic adjunct.⁴

If air embolism is suspected at the time of CVC removal, an occlusive dressing should be immediately placed over the insertion site to prevent further entrapment of air. The patient should be placed in the left lateral decubitus and Trendelenburg's positions. The left lateral position allows blood to pass through the inferiorly located pulmonary outflow tract. The head-down posture decreases the risk of a paradoxical air embolus to the brain from a patent foramen ovale. One hundred percent oxygen is administered to promote nitrogen reabsorption. If a central venous catheter can be placed, it can be used to aspirate blood from the right atrium. External cardiac massage may be help-

ful in displacing air from the heart into the pulmonary vasculature and allow for the return of cardiac blood flow. The pulmonary vasculature has a large capacitance to absorb the air. Finally, open thoracotomy and direct aspiration of the atrium, then the ventricles, may be required for resuscitation.³

Venous air embolism should be considered a completely preventable complication in regard to CVC removal. Several practical details and attention to certain risk factors are necessary. First, as with many so-called scut work, CVC removal, although simply performed, should not be taken lightly. Junior residents and medical students need to be educated about the potential for this often-fatal complication. Furthermore, they should be observed by more senior residents during several CVC removals. Central venous catheters should be removed with the patient supine, and the insertion site should be immediately covered with an occlusive dressing. Careful attention to the catheter itself is also important as open stopcocks or removed heplocks lead an open trail to the central venous circulation. Because a negative pressure gradient is necessary for air to be drawn into the catheter, inspiration should be avoided by having the patient at end-exhalation during catheter removal. Hypovolemia will contribute to an increased negative pressure gradient.

Comment

Venous air embolism is a potentially fatal complication of CVC removal, a procedure that is often delegated to junior residents and medical students. Adequate knowledge of the pathophysiology is necessary to diagnose, treat and, it is hoped, avoid entirely this complication.

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