

Patient Management Code Blue in the CT Suite

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Case Presentation

A 53-year-old woman experienced acute respiratory distress during an IV contrast enhanced CT scan of the chest, abdomen and pelvis. A code blue was signaled. Upon arrival, the patient complained of dyspnea but no chest pain.

Physical Examination

Her examination showed:

- Vitals: Resps 30, Pulse 110, BP 110/60
- Pulse Ox 80% on 3 L/min of O₂
- Inspection of her neck showed a midline trachea
- Chest examination revealed cyanosis, absent left-sided breath sounds and clear right lung by auscultation
- Heart auscultation revealed no murmur
- The abdomen was distended from ascites
- 2+ leg edema was present

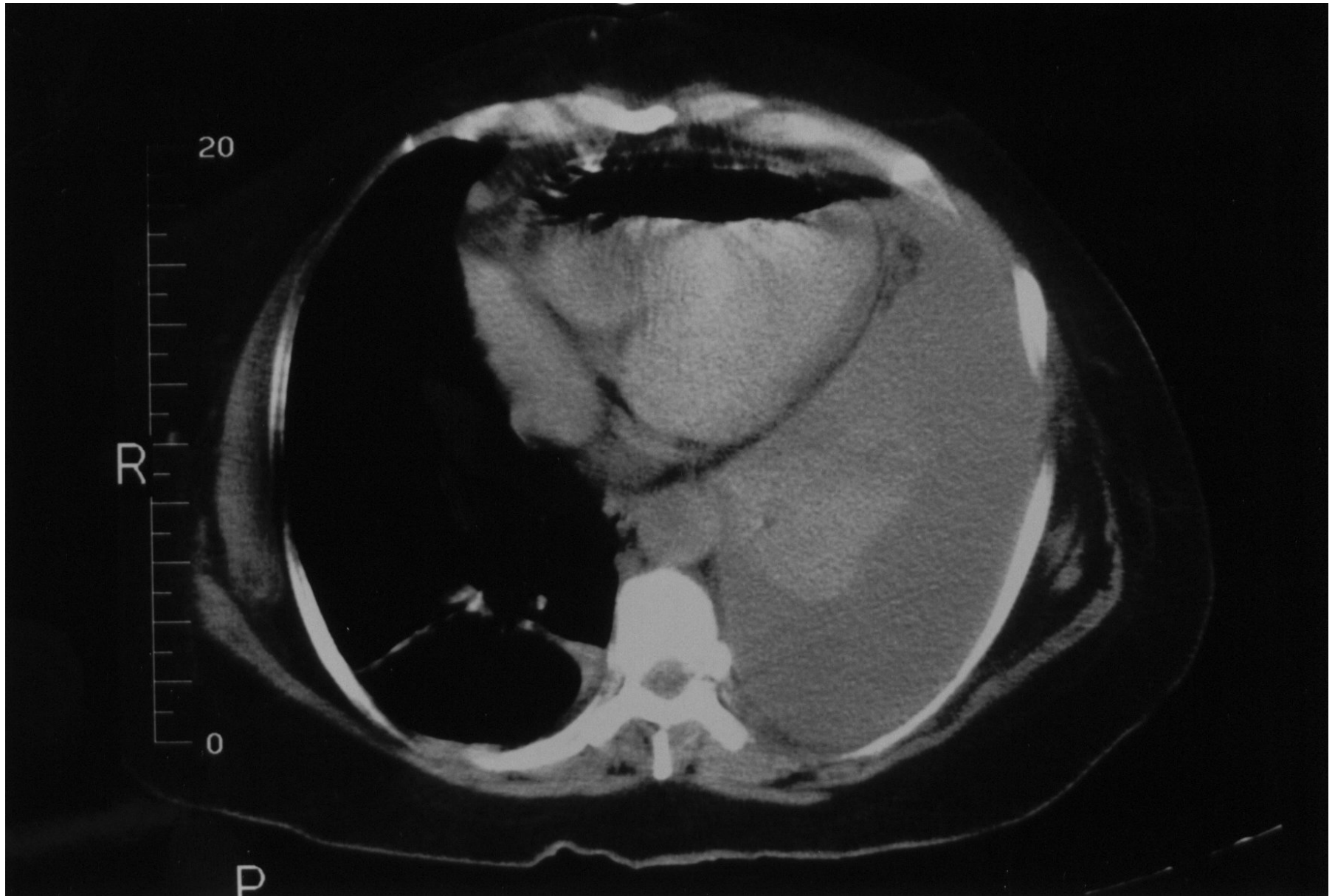
Differential Diagnosis

- Pneumothorax
- Anaphylaxis
- Pulmonary Embolism
 - Thrombosis
 - Air Embolism
- MI
- Cardiac Tamponade
- ARDS

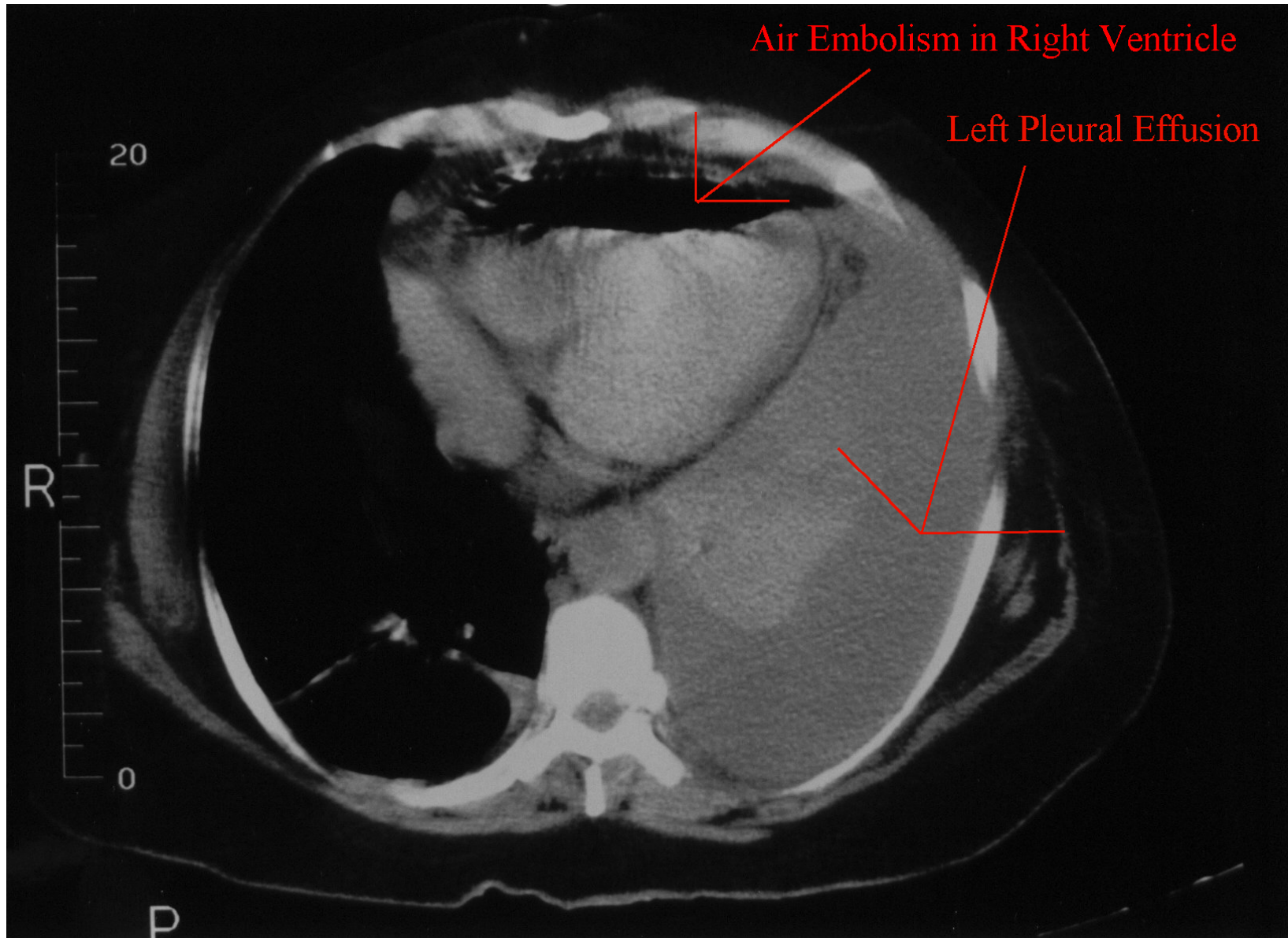
Chest Xray



Chest CT



Chest CT Reviewed



Air Embolism

- Occurs when gas enters systemic venous system
- Gas transported to lungs through pulmonary arteries
- Interferes with blood transport and gas exchange
- Leads to cardiac arrhythmia, pulmonary hypertension, right ventricular strain

Significance

- Air embolism occurs in up to 12% of patients undergoing IV contrast injection for CT scan
- When infused rapidly, 50 mL of intravenous air may lead to acute right heart failure and possible cardiac arrest.
- Larger amounts of intravascular air can be well tolerated if received at a slower rate of infusion

Etiology

- Many potential sources of air embolism
- Air entry favored by a pressure gradient from the superior venous sites to the right atrium
- Large-bore IV catheter access
- Neurosurgical and other surgical procedures where the patient is sitting
- Trauma
- Injury to the arms or legs may lead to venous air entry especially when the extremity is positioned superior to the right atrium or in the setting of shock

Diagnosis

- Consider in a hospitalized patient who develops rapid onset respiratory distress or cardiovascular compromise
- Characteristic “mill-wheel murmur” due to air-blood mixing within the cardiac chambers is rarely auscultated
- Intravascular air is best demonstrated by CT of the chest or bedside echocardiography

Treatment

- Immediate prevention of further air entry
- Place patient in left lateral decubitus position to minimize right ventricular air entering the pulmonary outflow tract
- Provide patient with 100% O₂
- Placement of a central venous catheter for evacuation of the air embolism can be attempted
- Hyperbaric oxygen is generally not used as first line therapy, but should be considered when there are neurological symptoms or signs suggesting a paradoxical embolism.

Create Diffusion Gradient

Providing patient with 100% FiO₂ elevates the nitrogen gradient and encourages diffusion of nitrogen from the intravascular air collection into the blood, accelerating the resolution of the air embolism

Embolism

Artery

Hyperbaric therapy

- Indicated for all arterial gas emboli
- 100% Oxygen at pressure above atmospheric
- Achieves P_{AO_2} up to 2000 mm Hg
- Decreases size of gas embolism due to increased pressure
- Creates high diffusion gradient to promote nitrogen absorption
- Increases tissue oxygenation
- Delayed treatment may still be beneficial

Alternative Therapies (Generally not recommended)

- Maintain normovolemia via IV infusion to maintain CVP at 12 mm Hg
- Heparin therapy may be beneficial in arterial embolization, but not generally recommended
- Corticosteroids are not recommended
- Lidocaine bolus of 1.5 mg/kg has been beneficial in animals

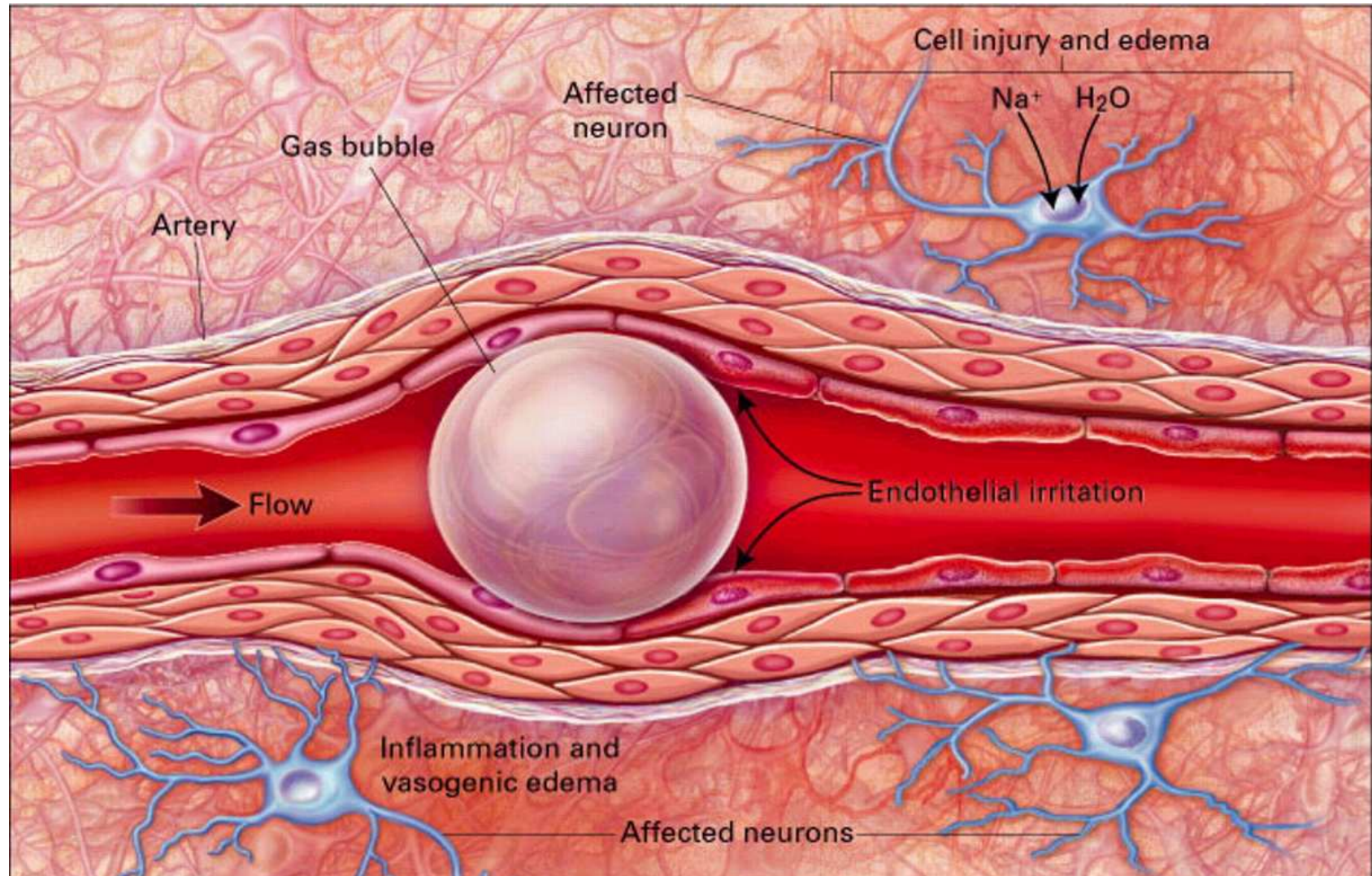
Paradoxical Embolism

- Occurs when air in the venous system migrates to the arterial system
- Often via patent foramen ovale (30% of general population)
- May be due to migration of massive venous embolism
- Signs include end arterial organ damage
- Place in flat position, otherwise treated the same as venous embolism
- Give higher consideration to hyperbaric therapy

Arterial Embolization

- Concerning targets include coronary arteries and cerebral vasculature
- Visceral and skeletal muscles tolerate arterial emboli reasonably well
- Two mechanisms of damage – reduced arterial perfusion and local inflammatory response to bubble

Arterial Embolization



Patient Code Blue Course

The CT scan of the chest showed a large left pleural effusion and approximately 40 mL of air in the right ventricle which was inadvertently introduced during IV contrast injection. The patient was emergently intubated and mechanical ventilation was initiated with 100% O₂.

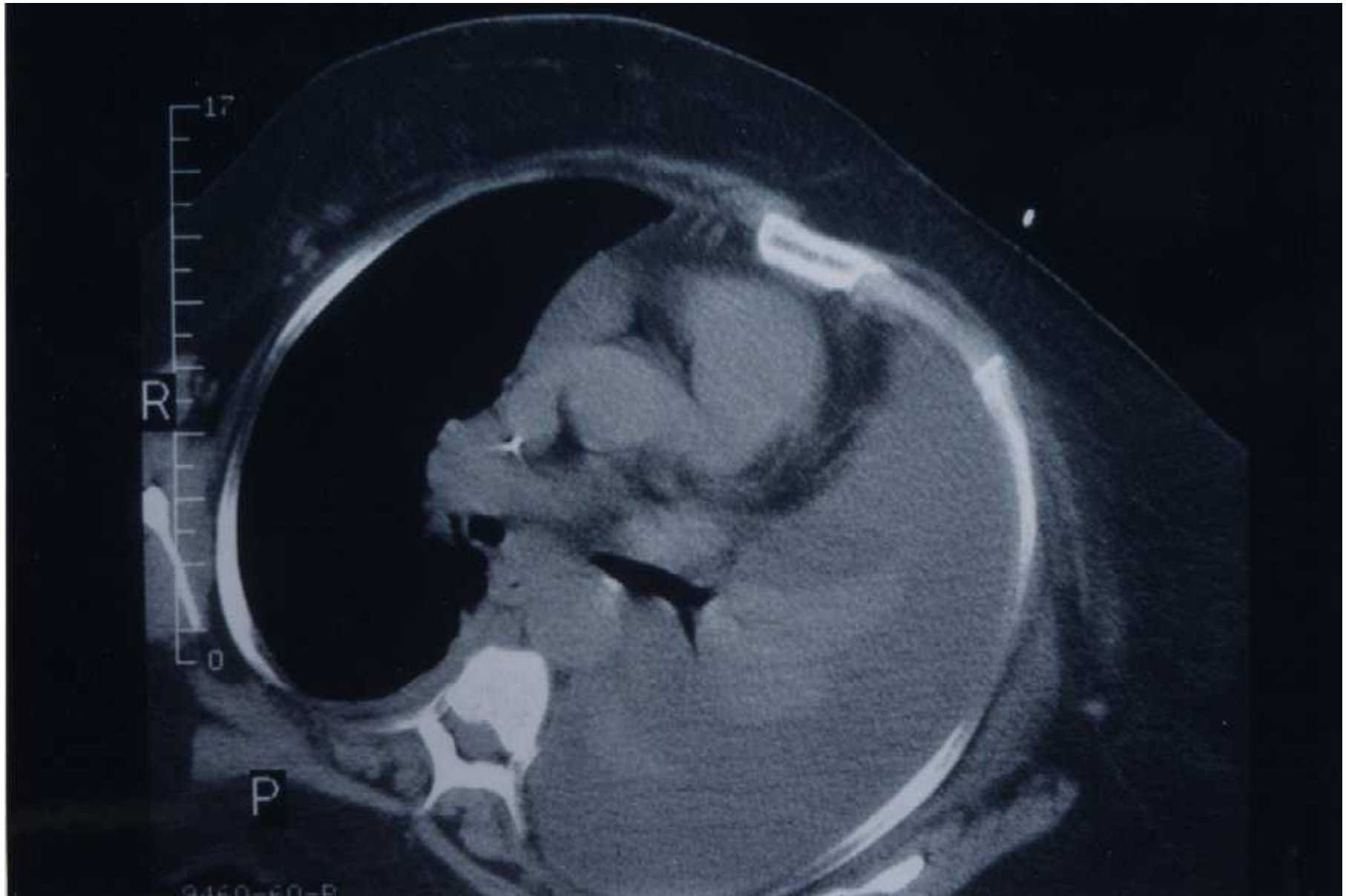
ICU Course

She was maintained in a left lateral decubitus position. A cordis catheter was inserted into the right internal jugular vein followed by introduction of a 20 cm triple lumen catheter. Approximately 20 mL of air and frothy blood were aspirated through the triple lumen catheter.

ICU Course

The patient remained intubated overnight. The following morning a quick-look echocardiogram revealed no evidence of air embolism. A followup chest CT also showed no residual air. She was successfully extubated 12 hours after intubation without further complication

Follow Up Chest CT



Comparison CT



Before



After

Conclusions

- Suspect air embolism in a patient with acute dyspnea and the right clinical setting
- Position patient and administer 100% Oxygen
- Watch for evidence of paradoxical embolism or neurological compromise and institute hyperbaric therapy if present

Bibliography

- Groell R, Schaffler GJ, Rienmueller R, et al. Vascular air embolism: location, frequency, and cause on electron-beam CT studies of the chest. *Radiology* 1997; 202:459-62.
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- Woodring JH, Fried AM. Nonfatal venous air embolism after contrast-enhanced CT. *Radiology* 1988; 167:405-07.