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A Case Study: Percutaneous Lung Biopsy and Symptomatic Arterial Air Embolus



Shawn Warren, RN^{*}, Andrew Somers, MSN, RN, CRN, Bailey Chambers, RN, Kiera Gardner, BSN

Department of Radiology, Duke University Medical Center, Box 3808 DUMC, Durham, NC 27710

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Air emboli are rare complications of computed tomography–guided lung biopsies. This case study discusses current recommendations on patient positioning and supportive treatment until an air embolus is reabsorbed or extracted. A plan of action aimed at mitigating the harmful or even fatal effects of air emboli should be developed and reviewed with all staff participating in these types of procedures.

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A 60-year-old Caucasian male presented for an outpatient computed tomography (CT)-guided percutaneous needle biopsy of a cavitary lesion of the right lower lung lobe which was discovered after performing a chest x-ray during a routine visit to a primary care provider. The radiology resident discussed procedural risks and benefits as part of the informed consent process, and a detailed history was taken and physical examination was performed, which revealed a significant smoking history of one pack per day for an undisclosed amount of years. The initial respiratory assessment appeared within desired limits as per the patient's baseline. Lung sounds were diminished in the bases, but breaths were even and unlabored on room air. No family history of lung cancer was reported.

Signed informed consents for the procedure and moderate sedation were verified by the nurse who brought the patient into the procedure room. Peripheral intravenous access and baseline vitals were obtained. The patient was then positioned in the left lateral decubitus position on the CT scanner. The patient's right side was exposed, and the technologist obtained scout images and a limited scan to assist visualization of the lesion and surrounding anatomical structures. The attending radiologist and resident identified the lesion position and a safe track for the biopsy needle. A timeout was performed, and a sterile procedure was carried out to clean the skin; the site was injected with 2% lidocaine for local

anesthesia. Concurrently, the patient received intravenous midazolam and fentanyl with little deviation from baseline vital signs. A Richmond Agitation-Sedation Scale score of –1 was noted consistently, and the patient remained compliant with breathing instructions during the insertion of a coring biopsy needle by a coaxial technique. Two tissue samples were obtained.

While waiting on the cytologist to call back regarding the sufficiency of the obtained tissue samples, the patient began to complain of mild chest pain. The radiologist was informed, and vital signs demonstrated a heart rate and blood pressure that were slightly elevated from baseline. The coaxial needle was removed, and a fluoroscopic scan was taken of the chest to check for a possible expanding pneumothorax.

At this time, the patient began to complain of severe chest pain characterized as sudden and accompanied by a feeling of impending doom. The radiologist performed a second scan, and a small focus of air was spotted in the ascending thoracic aorta. During this time, the patient's systolic blood pressure rose from 109 mmHg to 250 mmHg, and the heart rate increased from 53 bpm to 133 bpm. The patient did not experience an alteration in mental status, and oxygen saturation was unchanged.

The radiologist informed the nurse that it was an air embolism (Figure 1), and the patient was placed supine on the CT scanner. A nonbreather mask was placed on oxygen at 15 L. A “code blue” was called, which is the standard course of action in this department to ensure timely access to advanced care for acutely decompensating patients in danger of cardiac or respiratory arrest.

The patient was transferred to a stretcher and placed right side decubitus in the Trendelenburg position. The code team held the patient in a resuscitation bay in the emergency department while

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^{*} Corresponding author. Shawn Warren, Department of Radiology, Duke University Medical Center, Box 3808 DUMC, Durham, NC 27710.

E-mail address: shawn.warren@duke.edu (S. Warren).

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arranging for transfer to the hyperbaric oxygen chamber. He was then treated at 2 hours from onset of symptoms with hyperbaric oxygen at 2.8 atmospheric absolute for 85 minutes plus compression and decompression time. After the treatment, he reported a complete resolution of his chest pain, and return to baseline assessment was noted. He was discharged to home that same day without sequelae.

Discussion

Percutaneous lung biopsies are a relatively common interventional radiology procedure used to obtain tissue samples. Support for this procedure has risen sharply, in part, because the procedure has an overall accuracy of 95% and a positive predictive value for diagnosis of up to 99.3% (Fiore et al., 2017).

Risk

The procedure does carry a very small risk of air emboli of 0.001% to 0.45% in the population (Ishii et al., 2014; Lehmann and Frank, 2018; Tomiyama et al., 2006). The risk of systemic air embolism is 5.25 times higher for lesions in the lower lobe versus those in the middle and upper lobes, and the risk is infinitely higher when the procedure involves hemorrhage (Ishii et al., 2014; Tomiyama et al., 2006). Biopsy needles larger than 20 gauge are also a significant risk factor, posing a 10.1 times increased risk than a 20-gauge or smaller biopsy needle (Ishii et al., 2014). A few case reports suggest biopsies of cavitory or cystic lesions may increase the risk for an air embolism (Hare et al., 2011). No differences in risk for air emboli are reported between coaxial and noncoaxial methods (Ghafoori & Varedi, 2008).

Etiology

Air can enter the vascular space as a needle crosses through or is positioned in a vessel. As air enters the vessel in sufficient amounts, the resulting mechanical obstruction causes impaired blood flow to distal tissue. Another case study cited possible contributing factors as “coughing during the procedure, positive-pressure ventilation, a needle tip placed within pulmonary veins, and procedures performed for a cystic or cavitory lesion (Figure 2) and in patients with vasculitis” (Bou-Assaly, Pernicano, & Hoeffner, 2010).

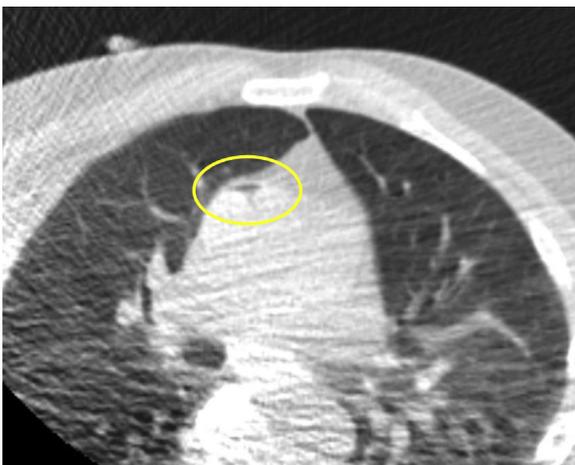


Figure 1. Fleck of air trapped in the aorta.



Figure 2. Cavitory lesion with biopsy needle present.

Patient Positioning

There is no consensus in the literature on how a patient suspected or known to have an air embolus should be positioned. Current recommendations for venous emboli include the left lateral decubitus or Trendelenburg position. Positioning for arterial air emboli should be supine or right side lateral decubitus with steep Trendelenburg (Ashizawa et al., 2004; Balsara et al., 2007; Shank et al., 2000).

Hyperbaric

The most effective method of removing arterial air emboli is by hyperbaric oxygen therapy (Figures 3 and 4). The hyperbaric chamber improves oxygenation of the affected tissue and dissolves the emboli by increasing nitrogen reabsorption. One study shows improved outcomes with the initiation of the hyperbaric chamber treatment within 6 hours while other studies suggest benefits are even possible with therapy initiation after the 6-hour window (Blanc et al., 2002; Berlot et al., 2018).

Additional Considerations

For health-care facilities with little or no access to a hyperbaric chamber, the patient may benefit from intracardiac catheter aspiration for treatment of an intracardiac air embolism (Her et al., 2017). Aside from the hyperbaric chamber and intracardiac catheter aspiration, high flow oxygen may help end organ oxygenation and help with reabsorption of the nitrogen bubble.



Figure 3. Hyperbaric chamber with control panel to the right.



Figure 4. Inside of hyperbaric chamber.

Conclusion

Percutaneous lung biopsies carry a small risk for introducing an air embolus to a patient. Given the potentially harmful nature of air emboli, it is important that a plan of action is formally developed to ensure early recognition and treatment. Patient positioning will differ between venous and arterial air embolism. With venous air emboli, the recommendation is left lateral decubitus or Trendelenburg position, and for arterial air emboli, it is supine or right side

lateral decubitus with steep Trendelenburg positioning. Hyperbaric oxygenation therapy is the definitive treatment for arterial air embolism. Without hyperbaric oxygenation therapy, the treatment for an air embolus is limited to giving high flow oxygen, patient positioning, and monitoring.

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