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Left Atrial Air Embolism Following Computed Tomography–Guided Lung Biopsy

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INTRODUCTION

Percutaneous lung biopsy using computed tomography (CT) guidance allows for minimally invasive histologic evaluation of pulmonary lesions. Although CT-guided lung biopsy is considered relatively safe, complications can arise. Pneumothorax and pulmonary bleeding are the most commonly reported complications, and both usually resolve with little or no treatment.[1] A feared complication of percutaneous lung biopsy is systemic or left atrial air embolism. Although rare, with incidences ranging from 0.02%-0.21%, such an embolism can lead to disastrous neurologic and cardiac morbidities.[2-4]

We describe the case of a patient who presented to interventional radiology for percutaneous CT biopsy of an incidentally detected pulmonary mass and developed a left atrial air embolus.

HISTORY

A 65-year-old male with no significant medical history was referred for chest radiograph prior to routine inguinal hernia repair. The chest radiograph demonstrated evidence of mass-like consolidation in the right mid lung zone that prompted a noncontrast CT scan of the chest. The CT scan demonstrated evidence of a 4.3-cm pulmonary mass in the right lower lobe (Figure 1), and the patient was referred for CT-guided lung biopsy.

RADIOGRAPHIC APPEARANCE AND TREATMENT

A CT-guided percutaneous biopsy was performed under moderate sedation with the patient in a prone position. Using CT guidance, a 19-gauge Tru-Guide coaxial sheath needle (C. R. Bard, Inc.) was advanced to the margin of the lesion in a posterior approach (Figure 2). During suspended respiration from the patient, 2 samples were obtained using a 20-gauge Monopty biopsy instrument (C. R. Bard, Inc.). However, following the second biopsy sample, a "whoosh" of air could be heard through the needle.

The stylet was reinserted, and the patient's vital signs did not demonstrate evidence of complication. The reviewing pathologist requested 2 additional samples. The "whoosh" of air was heard again after the third biopsy sample during suspended respiration. A quick decision was made to attempt a fourth sample as had been planned preprocedure. The fourth attempt yielded lung tissue, suggesting that the patient did not have a pneumothorax. The needle was swiftly removed, and a repeat CT scan was performed.

The postprocedure CT images demonstrated nondependent air within the left atrium (Figure 3). After the intracardiac air was discovered, the patient's vital signs were rapidly assessed and found to be stable. Cardiac monitoring revealed normal sinus rhythm. The patient was kept in the prone position and was placed on a 100% oxygen nonrebreather mask.

A second series of images obtained 30 minutes postprocedure demonstrated minimal interval reduction in the quantity of air within the left atrium (Figure 4). Because a hyperbaric oxygen treatment (HBOT) unit was not readily available, the decision was made to reposition the patient supine and in the 15-degree Trendelenburg position with the assistance of cardiology and critical care staff. Prior to patient rotation, the carotid arteries were simultaneously compressed for 5 seconds to generate a pressure gradient and temporarily force blood flow away from the brain while the patient was rotated. Carotid compression was released following patient rotation, and continuous telemetry monitoring was performed. The patient demonstrated no evidence of acute stroke or cardiac arrhythmia.

The patient's biopsy demonstrated evidence of low-grade adenocarcinoma that was successfully resected. The patient is now disease-free.

DISCUSSION

CT-guided percutaneous lung biopsy is a frequently performed interventional radiologic procedure. The primary risks associated with this procedure (pneumothorax and pulmonary hemorrhage) are well known and have well-established treatment guidelines.[2,5] However, left atrial air embolism is a much less common but potentially devastating complication. Air enters the pulmonary veins and travels into the systemic arteries via 2 main recognized mechanisms. The first mechanism occurs when a biopsy needle open to atmospheric pressure punctures a pulmonary vein.[6] If the pulmonary venous pressure decreases below atmospheric pressure, as during inspiration, air can enter through the needle and travel into the pulmonary veins. The second mechanism occurs when the biopsy needle punctures both a pulmonary vein and a bronchus, creating a bronchovenous fistula.[6] If the airway pressure exceeds the pulmonary venous pressure, as during a cough, air will enter the pulmonary vein.[7] In both mechanisms, air can propagate from the pulmonary veins into the left atrium, resulting in air embolism. Because the left atrium and

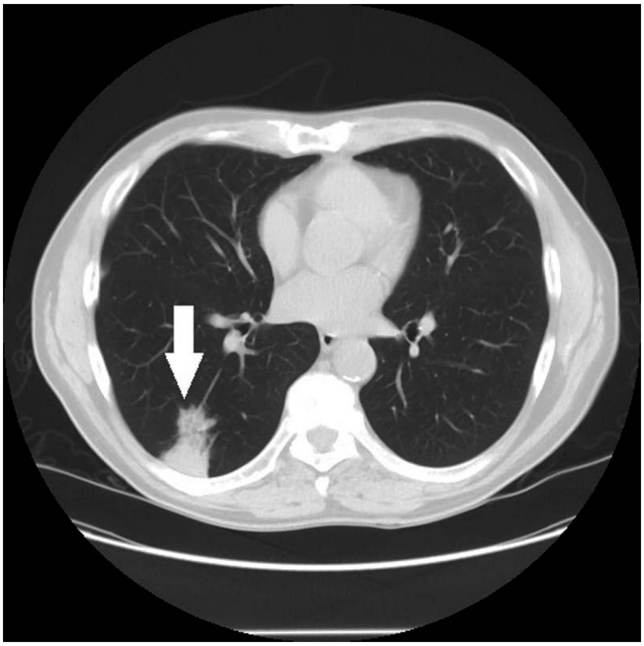

Figure 1. Computed tomography scan of the chest shows a 4.3-cm pulmonary mass within the posterior basal segment of the right lower lobe (arrow).

ventricle are systemic outflow chambers, these air emboli have the potential to obstruct arterial flow into various organs once they leave the left ventricle. Most small emboli in the skeletal muscles are tolerated, but emboli in the coronary and cerebral arteries can result in significant morbidity and death.[7] A coronary artery air embolism can result in a fatal cardiac arrhythmia, whereas a cerebral artery air embolism can result in a stroke.

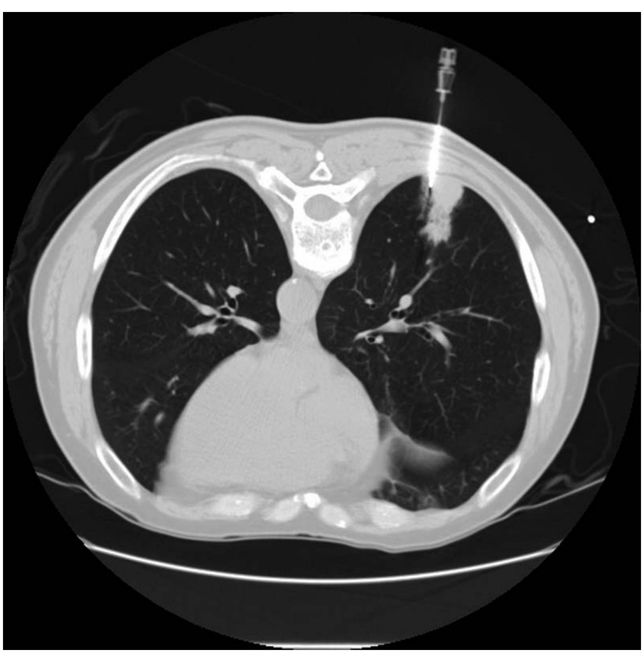

Figure 2. A 19-gauge Tru-Guide coaxial sheath needle is shown in satisfactory position within the right lower lobe mass just prior to performing the percutaneous biopsy.

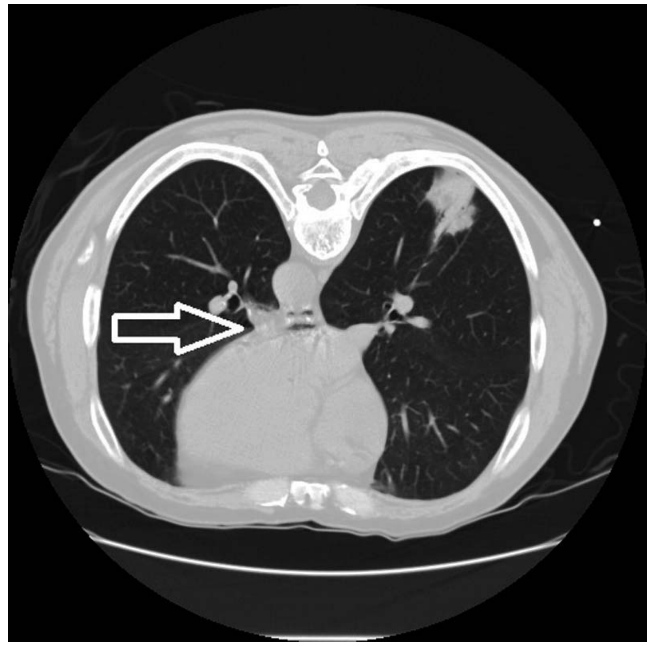

Figure 3. Postbiopsy computed tomography demonstrates intracardiac air along the nondependent, posterior aspect of the left atrium (arrow).

Certain conditions—vasculitis, coagulopathy, and inflammation—can predispose patients to air embolism by preventing the normal vascular hemostatic mechanisms. Diminished hemostatic mechanisms allow for prolonged exposure of the vessel lumen and an increased chance for air to enter.[3] Patients with obstructive lung disease are also at an increased risk because of increased airway pressures and obscured lung architecture.[8]

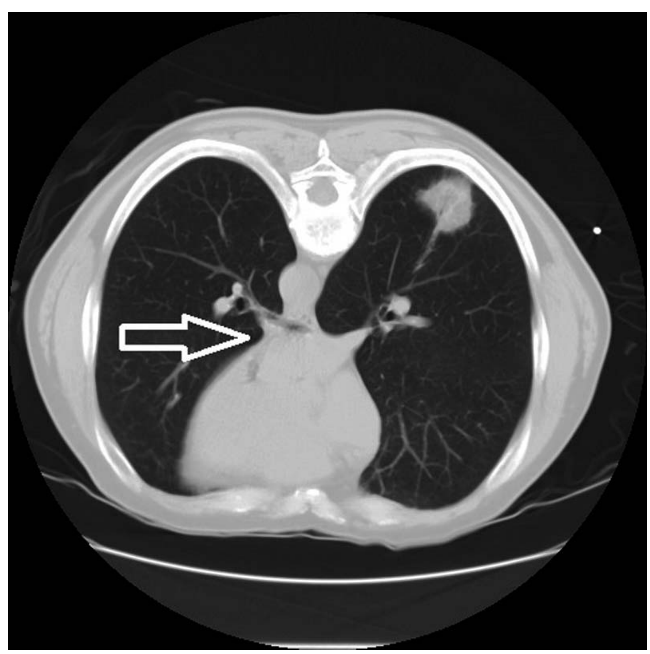

Figure 4. Repeat computed tomography performed 30 minutes after initial postbiopsy images demonstrates persistent air within the left atrium (arrow).

One case report attributed the air embolism to coughing because of a sudden increase in airway pressure, allowing the passage of air from a bronchovenous fistula or from an open needle into a pulmonary vein.[9] In our case, the patient's respirations were voluntarily suspended. However, minimal respiratory effort from the patient during the procedure could result in air embolism. Thus, limiting the exposure of the open needle is an important preventive measure and can be accomplished by covering the hub with a finger and replacing the stylet when not inserting the biopsy device. Using a drop of saline on the needle hub while the stylet is partially removed may also prevent air from entering the needle prior to inserting the biopsy device.[10]

Prompt recognition is necessary to enact immediate treatment for improved outcomes. A postprocedure series of images should be taken, and the patient should be monitored for clinical manifestations of stroke or cardiac arrhythmia. If an air embolus is seen on routine images or if the patient exhibits any neurologic or cardiac abnormalities, several crucial measures should be taken immediately. High-flow 100% oxygen should be administered. High-flow oxygen is thought to work by treating hypoxia and by establishing a diffusion gradient that facilitates the effusion of gas from the air bubbles.[11] Multiple theories exist about patient positioning following the development of a left atrial air embolism. Some suggest that the patient should remain in current positioning to prevent propagation of the air embolism.[1] The right lateral decubitus position keeps the inferior left heart outflow tract away from the superior nondependent portion where the air embolus resides.[6] However, right lateral decubitus positioning is encouraged once air has reached the left ventricle.[12] Regardless, most case reports advocate the Trendelenburg position to discourage the propagation of air into the carotid arteries and prevent stroke.

If the option is available, the patient should be immediately taken to an HBOT unit. HBOT works to dissolve the gas within the embolism bubble by increased nitrogen resorption using high-flow 100% oxygen and improves oxygenation of ischemic tissue.[6] HBOT has been shown to have a clear benefit if enacted within 6 hours of recognition of symptoms.[13]

Left atrial air embolism following CT-guided lung biopsy is an infrequently encountered complication with devastating implications if not swiftly and accurately identified by the interventional radiologist.

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