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Case Report

Treatment of Massive Systemic Air Embolism During Lung Biopsy

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Abstract

Percutaneous needle biopsy of lung lesions is commonly used and is usually regarded as a safe procedure with limited morbidity and extremely rare mortality. Most frequent complications are pneumothoax, pulmonary bleeding and hemoptysis. Other rare complications include systemic air embolus, tumor implantation and empyema. Systemic air emboli are extremely rare with a published incidence of 0.02% from a lung biopsy survey in the United Kingdom to 0.07% in the literature, but are serious and can be fatal. We present a case of massive air embolism occurring during lung biopsy and describe the technique used for immediate treatment.

Keywords: *Air-embolism, biopsy, hyperbaric oxygen, pneumothorax*

Introduction

We present a case of massive systemic air embolism during lung biopsy treated with catheter-assisted air aspiration and subsequent complete patient recovery.

Case Report

A 68-year-old female with a history of breast cancer status postbilateral mastectomy and breast reconstruction with silicone prosthesis referred for concomitant radiofrequency ablation (RFA) and biopsy of a newly seen 1 cm lingular nodule [Figure 1]. The procedure was initiated with double-lumen endotracheal tube intubation and general anesthesia with continuous positive end-expiratory pressure. Our routine is to place the radio frequency probe first, followed by coaxial biopsy of the lesion. Once the RFA probe was adequately positioned, a small anterior pneumothorax was noted and immediately treated with placement of an 8 Fr thoracotomy catheter. Pneumothorax resolved immediately [Figure 2]. A 19G trocar needle was then advance to the periphery of the lesion. As a repeat scan was performed to evaluate positioning, a large amount of free air was noted in the ascending aorta, coronary arteries, and left ventricle [Figure 3a-e]. Anesthesia was notified and hyperventilation was begun. The thoracotomy catheter was placed to high suction. Cardiothoracic surgery was consulted and declined any surgical intervention. Hyperbaric oxygen therapy was also declined due to the presence of pneumothorax.

At this time, while the patient still on the computed tomography (CT) table, access to the right common femoral artery was obtained and a 5 Fr sheath placed. A 5 Fr pigtail catheter was advanced over a Bentson wire until minimal resistance felt followed by sudden "give way," indicating passage through the aortic valve. Blood was initially aspirated using a 60 cc syringe and the catheter was slowly pulled out. Approximately 20 cc of air was then aspirated followed by blood return. This maneuver was repeated three times until no air could be aspirated. Repeat CT revealed complete resolution of the air embolism [Figure 4a-c]. CT scan of the brain revealed no free air in the cerebral circulation and no ischemic changes in the brain parenchyma. The biopsy was then completed and RFA performed. The patient remained intubated and hyperventilated for 6 h after which she was successfully weaned and extubated. No neurological deficit was noted. The patient was discharged 2 days later.

Discussion

Percutaneous needle biopsy of lung lesions is commonly used and is usually regarded as a safe procedure, with limited morbidity and extremely rare mortality. Most frequent complications are pneumothorax (27%), pulmonary bleeding (11%), and hemoptysis (7%).[1-3] These are usually conservatively

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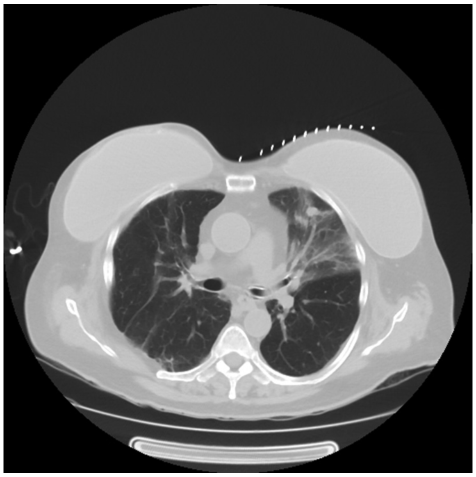

Figure 1: Prebiopsy lingular nodule

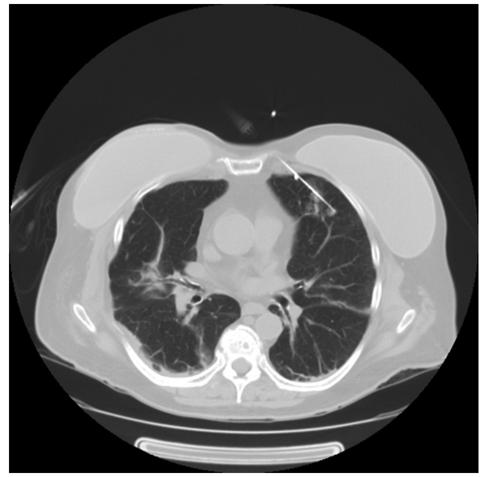

Figure 2: Postradiofrequency ablation probe placement with small pneumothorax

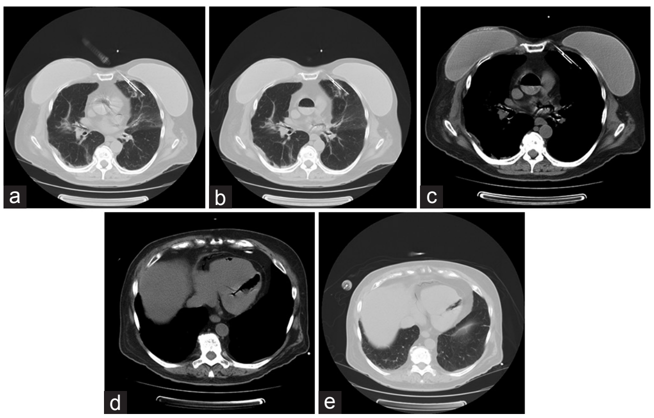

Figure 3: (a and b) Lung windows with free air in the ascending aorta and left pulmonary vein, (c) mediastinal windows with free air in the ascending aorta and left pulmonary vein, (d) mediastinal windows with free air in the coronary arteries and left ventricle, (e) lung windows with free air in the coronary arteries and left ventricle

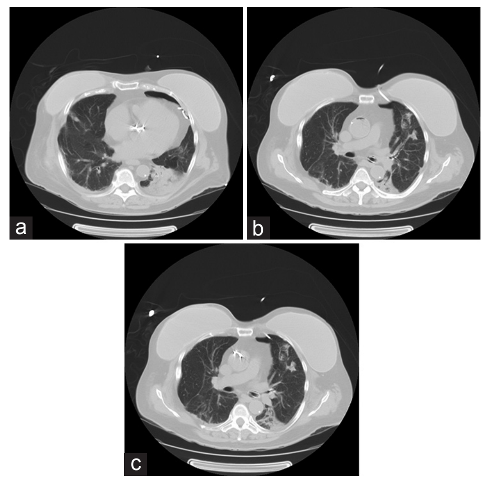

Figure 4: Pigtail catheter across the aortic valve (a) with resolution of free air in the left ventricle and near-complete (b) and subsequent complete resolution of free air in the ascending aorta (c)

treated and self-resolving. Other rare complications include systemic air embolism, tumor implantation, and empyema. Systemic air embolism is extremely rare with a published incidence of 0.02% from a lung biopsy survey in the United Kingdom to 0.07% in the literature[2-6] but is serious and can be fatal. To the best of our knowledge, 19 cases have been published in the last 30 years.

Air in the pulmonary venous system embolizes mainly to coronary and cerebral arteries. Only 2 mL of air injected into cerebral circulation can be fatal, and 0.5–1.0 mL injected into pulmonary veins can cause cardiac arrest from coronary embolism.[4]

There are three possible ways air can be introduced into the pulmonary venous system during percutaneous needle biopsy of the lung. First, air may directly enter the pulmonary system through the needle if the needle is placed into a pulmonary vein while the base is exposed to the atmosphere when the stylet is removed, and the atmospheric pressure exceeds the pulmonary veins pressure as may occur during deep inspiration. Second, air may be introduced into the pulmonary arterial circulation and then reach the pulmonary veins by traversing the pulmonary microvasculature. Third, a needle may penetrate simultaneously at an air-containing space, such as a nearby pulmonary alveolar space, bronchus, cavity or air cyst, and a nearby pulmonary vein, which can create a communicating fistula. Then cough, straining, or Valsalva maneuvers can increase the pressure in the air-containing space, resulting in air embolism.[2-11,3] Some factors are thought to be contributors: Coughing during the procedure, positive-pressure ventilation, a needle tip placed within pulmonary veins, and procedures performed for a cystic or cavitary lesion and in patients with vasculitis.[8]

Some authors postulated an increased probability of gas embolism related to the size of the needle and the coaxial techniques since larger needles have an increased risk of involvement in a pulmonary vein and the coaxial method increases the risk of contact with the atmosphere after removal of the internal stylet. However, a number of reported cases have described systemic air embolism with smaller needles and without the use of coaxial method, questioning any relationship between the two factors.[6]

The use of normal saline for sealing the needle track has been reported to significantly reduce the incidence of pneumothorax and prevents subsequent chest tube placement after CT-guided lung biopsy.[7]

Diagnosis of a systemic air embolism is difficult. It is mainly clinically suspected based on the deterioration of the patient's neurologic and cardiovascular status. Brain and chest CT scan can provide a definitive diagnosis by showing air bubbles in cerebral vessels, aorta, left atrium, and ventricle or pulmonary veins. Coronary embolism may cause myocardial ischemia, decreased myocardial function, and sudden death. Cerebral air embolism may cause focal defects, seizure, and coma. An ophthalmoscopy examination may demonstrate air bubbles in the retinal vessels.[4] Some authors reported that systemic air embolism is underestimated since it is undiagnosed in asymptomatic patients.[6,12] The initial treatment consists of immediate administration of 100% oxygen and placing the patient in the left lateral decubitus position with lowering of the head.[4-6,11,12]

Hyperbaric oxygen therapy is considered the first-line therapy for systemic air embolism by reducing bubble volume and improving tissue oxygenation.[13] The size of a gas bubble is inversely proportional to ambient pressure at constant temperature.[14] Breathing 100% oxygen at a pressure above that of the atmosphere decreases the size of gas bubbles by raising ambient pressure and also causes systemic hyperoxia.[6,8,15,7] Hyperoxia produces diffusion of oxygen into the bubble and nitrogen out and also allows a large quantity of oxygen to dissolve in the plasma and increases oxygen diffusion in tissues. Furthermore, it prevents cerebral edema by reducing the permeability of blood vessels while supporting integrity of blood–brain barrier.[6,9,14]

With cerebral embolism, immediate hyperbaric therapy was reported to decrease the mortality rate to 7%.[4,7] Although immediate treatment is recommended, delayed hyperbaric oxygen therapy may also increase survival and decrease the neurologic deficit, even many hours after the incidence because air bubbles have been demonstrated at 48 h after initial events.[4] In our case, hyperbaric oxygen was considered to be ineffective due to the presence of a pneumothorax and potential oxygen leakage to the chest tube.

Several considerations have been recommended to reduce the risk of air embolism such as avoiding biopsy through a cystic or cavitary lesion or bullous lung parenchyma, using a stylet and keeping an occluded hollow at all times, requesting the patient to stop breathing when manipulating the biopsy kit and to restrain from coughing and straining, and penetrating the least amount of parenchyma to reach the lesion.[7]

Despite the rarity of this dangerous and eventually fatal complication, interventional radiologists should be aware of the possibility of systemic air embolism after lung biopsy and should be ready to provide emergent management for the treatment of the patient. Although several recommendations and precautions have been proposed to reduce the risk of this complication, it may be inevitable and can occur despite long experience and meticulous care.[16] The immediate maneuver of placing a pigtail catheter in the left ventricle and aspirating large amount of free air has proven to be lifesaving in our case. While it can be potentially dangerous without fluoroscopic guidance, it was felt that transporting the patient to the angio suite would cause the loss of precious time and could be fatal. Fortunately, we had a positive outcome.

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Conflicts of interest

There are no conflicts of interest.

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