Fatal coronary artery air embolism during CT guided percutaneous lung biopsy

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Conflict of Interest: None

ABSTRACT

Computed tomography (CT) guided percutaneous transthoracic needle biopsy of lung lesions is a well-established and commonly performed procedure to obtain tissue for histopathology and immuno analysis. The most common complication of the procedure is pneumothorax followed by hemorrhage. Severe complications such as systemic air embolism are rare but can result in significant morbidity and can be potentially fatal if embolization occurs to cerebral or coronary circulation (arteries).

We present a case of fatal left coronary artery air embolism sustained during attempted CT guided transthoracic lung biopsy.

CASE REPORT

BACKGROUND

Computed tomography guided percutaneous transthoracic needle biopsy of lung lesions is a well-established and commonly performed procedure to obtain tissue for histopathology and immuno analysis. The most common complication of the procedure is pneumothorax followed by hemorrhage. Severe complications such as systemic air embolism are rare but can result in significant morbidity and can be potentially fatal if embolization occurs to cerebral or coronary circulation (arteries).

We present a case of fatal left coronary artery air embolism sustained during attempted CT guided transthoracic lung biopsy.

CASE REPORT

A 76-year-old male with a history of rheumatoid arthritis presented with pruritic rash and cough with blood-tinged sputum of two weeks duration. Chest X-ray was significant for new left lower lobe and right upper lobe nodules. Subsequent CT imaging revealed emphysematous lungs with bilateral pulmonary nodules measuring more than 2 cm in the right upper and right middle lobes and left lower lobe nodule with cavitation. Immunologic workup, purified protein derivative test, blood cultures, gram stain and acid-fast bacilli were negative. Sputum cultures showed mycobacterium avium complex. CT abdomen and pelvis revealed 2.7 cm partially calcified mass along the left lateral wall of the urinary bladder and urine cytology showed highly atypical urothelial cells suspicious for urothelial carcinoma.

With this new diagnosis of urinary bladder mass, lung metastasis was in differential diagnosis along with primary lung malignancy and lung lesion biopsy was requested to differentiate.

A solid nodule in the posterior left lower lobe was selected as target for percutaneous transthoracic needle biopsy. Initially the patient was positioned left lateral decubitus; but the patient could not tolerate this position due to shoulder pain despite administration of conscious sedation using 1 mg midazolam and 50 micrograms of fentanyl. Semi-prone positioning was the most tolerable position for the patient. After localizing the left lobe nodule utilizing CT, a 25-gauge 3.5-inch Whitacre needle was advanced under CT guidance into soft tissues to achieve

local anesthesia along the trajectory to the target nodule. Approximately 3 cc of 1 % lidocaine was administered, and stylet was reinserted. Immediately the patient became restless and cyanotic. CT scan of the chest was performed to rule out pneumothorax. Condition team was called to get additional help for advanced cardiac life support. Resuscitation was started with intravenous fluids and 0.4 g of intravenous Narcan was administered to reverse the opioid overdose if any. The patient quickly became unresponsive with severe hypotension, hypoxia, and agonal breathing. The blood pressure rapidly dropped to mean arterial pressure of 40 mm Hg, peripheral oxygen saturation dropped to low 60s and the patient quickly lost the pulse. The code team arrived to manage acute cardiopulmonary deterioration. Advanced cardiac life support was started and carried out for 45 minutes, but the patient could not be revived.

The initial evaluation of the CT images by the interventional radiologist was brief, as the need for managing the patient's vital signs was more critical. Arrival of the code team enabled careful thorough review of the CT images. No pneumothorax or tension physiology was seen. However, the tip of the lidocaine needle was noted in the periphery of the lung. There were no bleeding complications on CT images such as hemothorax, or pericardial tamponade or parenchymal hemorrhage or aspiration of blood or mediastinal widening. However, air was noted in the systemic circulation in the left ventricle (Figure A) and along the epicardium (Figure B) in the left coronary artery. The clinical suspected cause of death was cardiopulmonary arrest due to air embolism to coronary circulation. The patient underwent the autopsy. Autopsy findings showed significant atherosclerosis of the coronary arteries with 75% occlusion of the proximal left anterior descending and 90% occlusion of the left circumflex coronary artery. There was calcified atherosclerosis of the abdominal and thoracic aorta. The peripheral location, microscopic features and immunohistochemical profile of the lung nodule were consistent with large cell neuroendocrine carcinoma. No air was noted in the ventricle, atrium or within coronary artery. This is most likely due to a very small amount of air.

However, air was elicited from the right subclavian region upon dissection in the region of subclavian venous line placement.

DISCUSSION

Percutaneous needle biopsy of lung lesions is a well-established procedure. The most common complication of the procedure is pneumothorax with 27-49% incidence [1]. The second most complication is intraparenchymal hemorrhage (11%), followed by hemoptysis (< 7 %) [1]. Usually, these complications either resolve spontaneously or respond to minimal intervention [2]. Severe complications such as massive hemoptysis, tension pneumothorax, tumor seeding of the biopsy tract or air embolism are rare [3]. The incidence of clinical/ symptomatic air embolism during lung biopsy is reported between 0.01 % to 0.21% [4,5], however the radiological incidence of air embolism is reported as high as 3.8 % in some studies [4]. Coronary artery embolism is even rarer [6].

The possible mechanisms the air can enter systemic circulation during lung biopsy are:

1) When the biopsy needle tip is in the pulmonary vein, resulting in direct communication to atmospheric air.

2) Development of broncho-pulmonary vein fistula.

3) As a paradoxical embolism in patients with right to left shunt.

4) Air passage from the pulmonary artery into the pulmonary vein via microcirculation.

Systemic air embolization can result in gas bubbles in any organ. Small gas emboli in the vessels of the skeletal muscles or other viscera are tolerated well, but embolization to the cerebral or coronary circulation can result in severe morbidity or mortality [7].

The small amount of air in coronary circulation can induce cardiac ischemia by means of:

1) Producing vapor lock and resultant blood flow obstruction to myocardium.

2) Generating intense coronary vasospasm.

3) Activating platelets resulting in micro thrombi within coronary arteries [2].

The most common reasons for coronary artery embolism are accidental iatrogenic introduction of air bubbles into the aorta or coronary arteries during the coronary angiography, cardiac surgery, neurosurgery in upright position, and barotrauma due to positive pressure ventilation. Lung biopsy as a cause of coronary artery embolism is extremely rare. However as little as 2 to 3 mL of air into pulmonary vein circulation can prove fatal [5]. Apart from cardiac ischemia and infarction, air in coronary arteries can lead to dysrhythmia and cardiac arrest.

The risk factors associated with increased incidence of air embolism during lung biopsy include cavitary lung lesions, vascular nature of the lesion, chronic obstructive pulmonary disease (COPD) with associated air trapping, larger bore size of the biopsy needle, and coughing during biopsy. Vasculitis and positive ventilation have been identified as additional risk factors. Consolidated lung prevents vessel retraction and can predispose to air embolism [8]. COPD with associated post-inflammatory changes makes lung tissue friable, possibly contributing to pulmonary vein-airway fistula and increased risk of air embolism. Sustained expiration, rather than inspiration, during the biopsy is recommended by some operators to prevent air embolism in cooperative patients capable of following instructions to hold breath in expiration [1]. Similarly, performing biopsy in ipsilateral decubitus position, rather than prone, reduces the probability of air embolism [9]. Positioning the lesion below the level of the left atrium can prevent air embolizing to coronary, cerebral, or spinal circulation [9].

Coughing episodes during biopsy can increase pressure within the pulmonary airways, easily overriding the pulmonary vein pressure (10 cm of water). Similarly, COPD with air trapping can result in increased airway pressure leading to increased gradient between the airway and the pulmonary vein.

In the present case, a non-cavitary mass was targeted for biopsy. The patient had underlying emphysematous changes within the lung parenchyma, which is a known risk factor for air embolism. The patient was unable to hold their breath. Ipsilateral (left) decubitus position was tried to keep the target below the level of the left atrium, but the patient found this intolerable due to shoulder pain. No coughing episode was noted during the procedure. The needle hub was not exposed to atmospheric air. Most likely, air entered the pulmonary vein via communication with an air containing structure such as bronchus/alveolus.

Identification of air on CT scan is not difficult. Once air embolism is diagnosed, the patient can be positioned in Trendelenburg's position with contralateral side down. However, some consider even a flat supine position sufficient [7]. Hyperbaric oxygen therapy is suggested for treating air embolism [5,7,10]. 100% oxygen therapy also produces significant improvement [10].

Our patient did not receive the above therapies, as resuscitative attempts by the radiologist prior to code team arrival and rapid progression into cardio-pulmonary arrest occurred before air embolism could be diagnosed on CT scan.

CONCLUSION

Systemic air embolism during lung biopsy is a known, but rare, complication. Air embolism can occur with as thin as the 25 G needle. Small amount of air embolism to the coronary artery can prove rapidly fatal.

TEACHING POINT

After more common complications such as pneumothorax and bleeding are ruled out as causes of patient's sudden deterioration of clinical status, systemic air embolism should be suspected as etiology after percutaneous lung lesion biopsy.

Systemic air embolism can occur with thinner needles and can prove fatal if air lodges in vital circulation as coronary arteries.

QUESTIONS & ANSWERS

1) The most common complication of percutaneous lung lesion biopsy is.
   a) Air embolism
   b) Bleeding
   c) Pneumothorax
   d) Hemoptysis
   e) None of the above
   Answer: C: Pneumothorax

2) If the patient is cooperative, the ideal phase of respiration to perform percutaneous lung biopsy?
   a) Deep inspiration
   b) End expiration.
   c) Does not matter.
   d) Intubation & mechanical ventilation
   e) All of the above
   Answer: b) end expiration

3) The mechanism air can enter systemic circulation during lung biopsy.
   a) Direct communication of pulmonary vein to atmospheric air
   b) Iatrogenic broncho-pulmonary fistula
   c) Right to left shunt.
   d) Via microcirculation
   e) Any of the above
   Answer: e) Any of the above

4) Factors to prevent the risk of air embolism during percutaneous lung biopsy.
   a) When possible, do biopsy in ipsilateral decubitus position.
   b) Avoid cavitating lesion.
   c) When possible, position the lesion below the level of left atrium.
   d) Smaller gauge biopsy needle which yields diagnostic specimen
   e) Any of the above
   Answer: e) Any of the above

5) Treatment of systemic air embolism include:
   a) Trendelenburg position with contralateral side down
   b) Hyperbaric oxygen treatment
   c) 100 % Oxygen is an alternative.
   d) Supportive measures
   e) All the above
   Answer: e) All of the above

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FIGURES

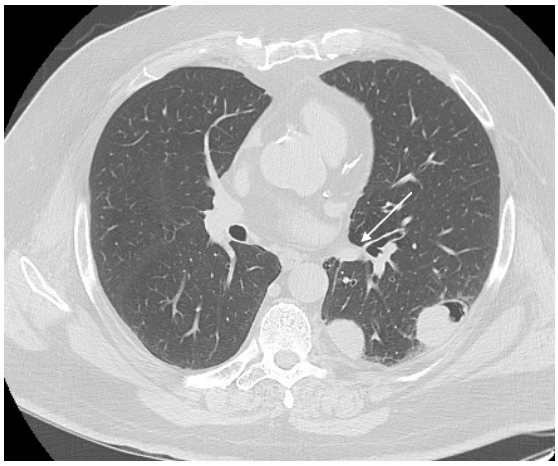

Figure 1: Axial CT image lung window show multiple left lower lobe lesions. The medial non-cavitating lesion was targeted for biopsy (arrow)

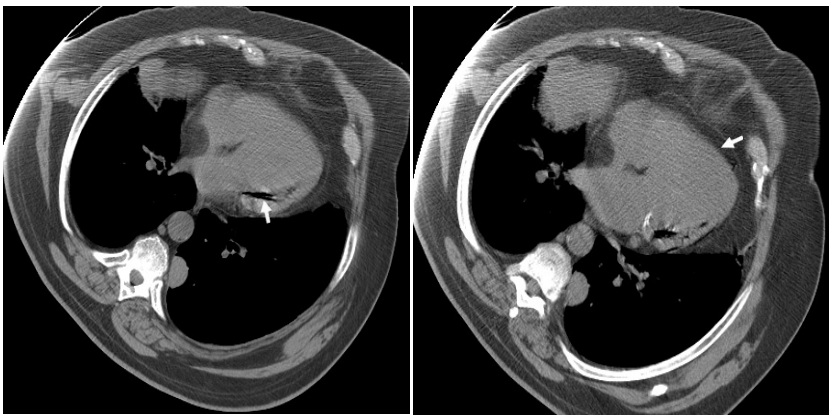

Figure 2: Axial non contrast CT images after biopsy shows air (arrow) in the left ventricle (A) & in the epicardium along the course of the left coronary artery (B).

Table 1: Cases of coronary artery air embolism from literature following percutaneous lung lesion biopsy

Sr No	Author	Journal	Patient	Clinical presentation	Nodule location	Air embolism site	Management	Follow-up
1	BW Arnold et al	AJR 2002	60 Y/M	Hemoptysis	Left lower lobe	Coronary arteries	Cardiac resuscitation	Died on CT table
2	A Mansour et al	CVIR 2005	52 y/M	Cavitating lung lesions	Right upper lobe	Right coronary artery	Resuscitation in cardiac ICU	Discharged to home after few days
3	HM Cheng et al	BJR 2010	35 Y/M	Tongue cancer with multiple cavitary lung lesions	Lingula	Right coronary artery	Resuscitation in cardiac ICU PPV with 100% oxygen	Died 4 months later from tongue cancer
4	SS Hare et la	Clinical Radiology 2011	67 Y/F	Not described	Left upper lobe	Right coronary artery	Hyperbaric Oxygen	Full recovery with 6 hours
5	T Kawaji et al	Circulation 2012	77 Y/M	Cardiomyopathy on amiodarone Screening CT scan done for interstitial pneumonia	Right middle lobe	Right coronary artery	Temporary pacing Coronary angiography and vasodilators	Discharged at 13 days
6	A Deshmukh et al	IJRI 2021	52 Y/M	Cough & hemoptysis with multiple lung nodules	Right anterior lobe	Right coronary artery	100 % oxygen Atropine Dopamine Cardiac catheterization	Lost to follow up

KEYWORDS

Coronary; Embolism; Lung; Biopsy; Complication