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Case report

Acute Coronary Artery Air Embolism Complicating a CT-guided percutaneous lung biopsy: A case report

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ABSTRACT

Systemic air embolism is a fatal complication of computed tomography-guided percutaneous lung biopsy. Here, we report a case of acute coronary artery air embolism following computed tomography (CT) guided percutaneous lung biopsy. The patient exhibited cardiac symptoms, and CT showed air density in left ventricle and aorta, indicating air embolism. Trendelenburg positioning and coronary angiography were performed during the treatment, and the patient was discharged without obvious complications.

1. Introduction

CT-guided percutaneous lung biopsy helps in diagnosis pulmonary diseases, and the common complications include pneumothorax and hemorrhage [1–3]. Systemic air embolism is a rare complication that can lead to severe organ damage and can even be fatal, the incidence of symptomatic air embolism is approximately 0.08%–0.49%, and asymptomatic air embolism events are not detected leading to underestimation of air embolism as a complication [3–5]. Coronary artery air embolism is a fatal event that occurs uncommonly with coronary angiography and cardiac catheterization; however, there are few reports of systemic air embolism after CT-guided percutaneous lung biopsy in literature [6–9]. We report a case of acute coronary artery air embolism following CT-guided percutaneous lung biopsy and also discuss treatment strategy and follow up of the patient.

2. Case report

A 58-year-old man from East Asia was admitted to evaluate lung adenocarcinoma treatment response. He had undergone lung segmentectomy of the posterobasal segment of right lower lobe two years ago and had received adjuvant chemotherapy. He was simultaneously diagnosed with idiopathic pulmonary fibrosis and type 2 diabetes and reported no hypertension or coronary heart disease. A CT-guided percutaneous biopsy was performed to evaluate newly detected pulmonary nodule in the left lower lobe (Fig. 1a and supplementary materials).

An experienced radiologist performed the intervention. The patient was placed in the right lateral position and was required to hold breath when necessary. The suspected lesion was positioned and punctured using an 18-gauge coaxial biopsy needle under CT

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guidance, and two specimens were successfully obtained (Fig. 1 b and c). After removing the biopsy needle, the patient started exhibiting dyspnea, cough, profuse sweating, restlessness, and precordial pain. CT revealed a small pneumothorax and massive air embolism in the left ventricle and aorta (Fig. 1 d-i). The patient was transferred to the emergency department, provided with 100% high-flow oxygen inhalation, and placed in the right lateral Trendelenburg position. A 12-lead electrocardiogram (ECG) showed ST-segment elevation in leads I, aVL, V5, and V6 (Fig. 2a). Morphine (10 mg, intramuscular injection) and isosorbide mononitrate (4 mg/h, continuous intravenous infusion) were administered to relieve pain and expand the coronary artery. Blood biochemical examination showed mild hypokalemia (3.4 mmol/L), and potassium magnesium aspartate (50 mL, containing 516.5 mg of K^+ and 168.5 mg of

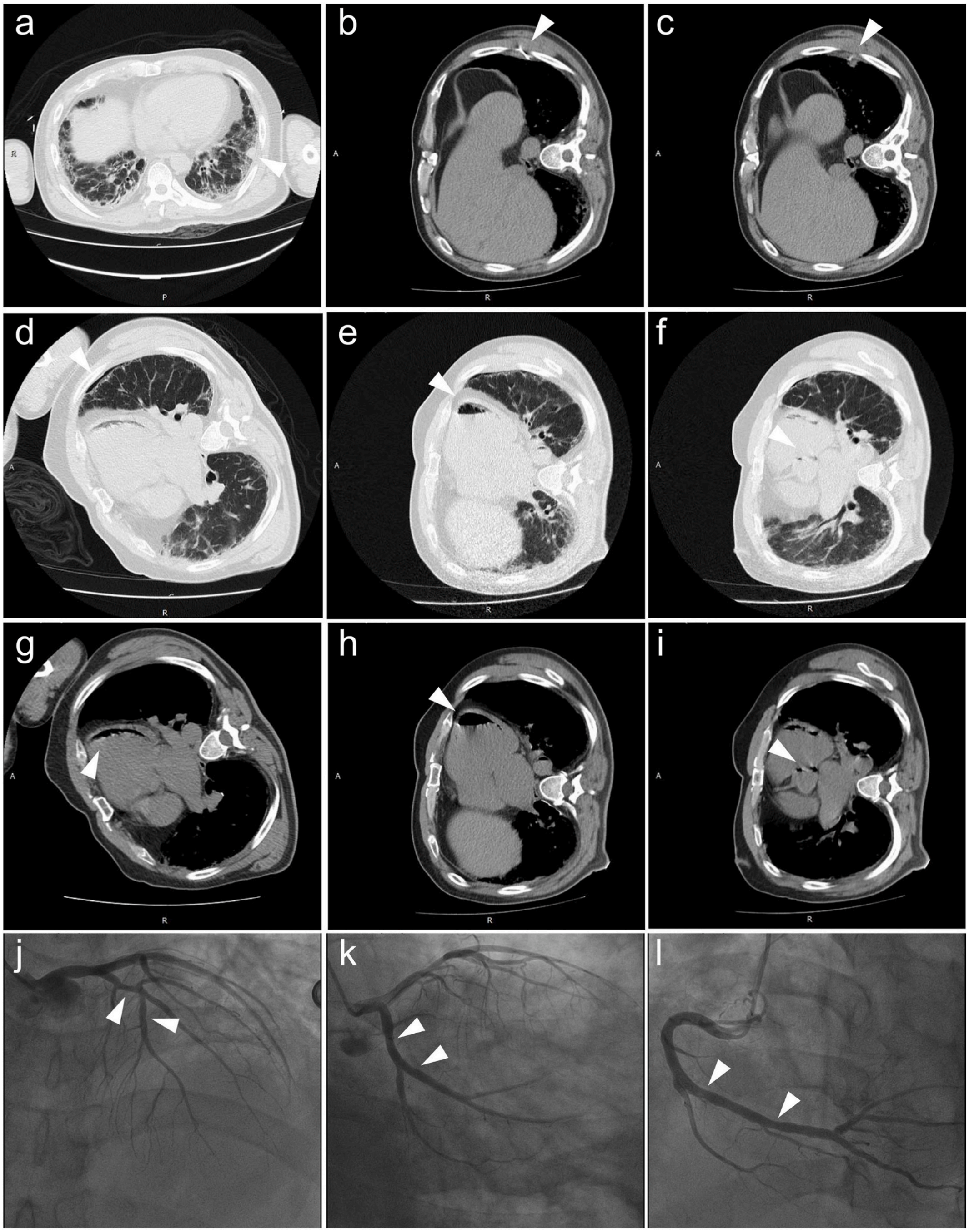

Fig. 1. a: A pulmonary nodule in the left lower lobe. b and c: The biopsy needle was introduced into the nodule. d–i: A slight pneumothorax in the left lung; a massive air embolism in the left ventricle apex and aortic root. j–l: Stenosis and plaques in LAD, LCX, and RCA; slow blood flow was observed in the left coronary artery (supplementary materials); no obvious obstruction was detected.

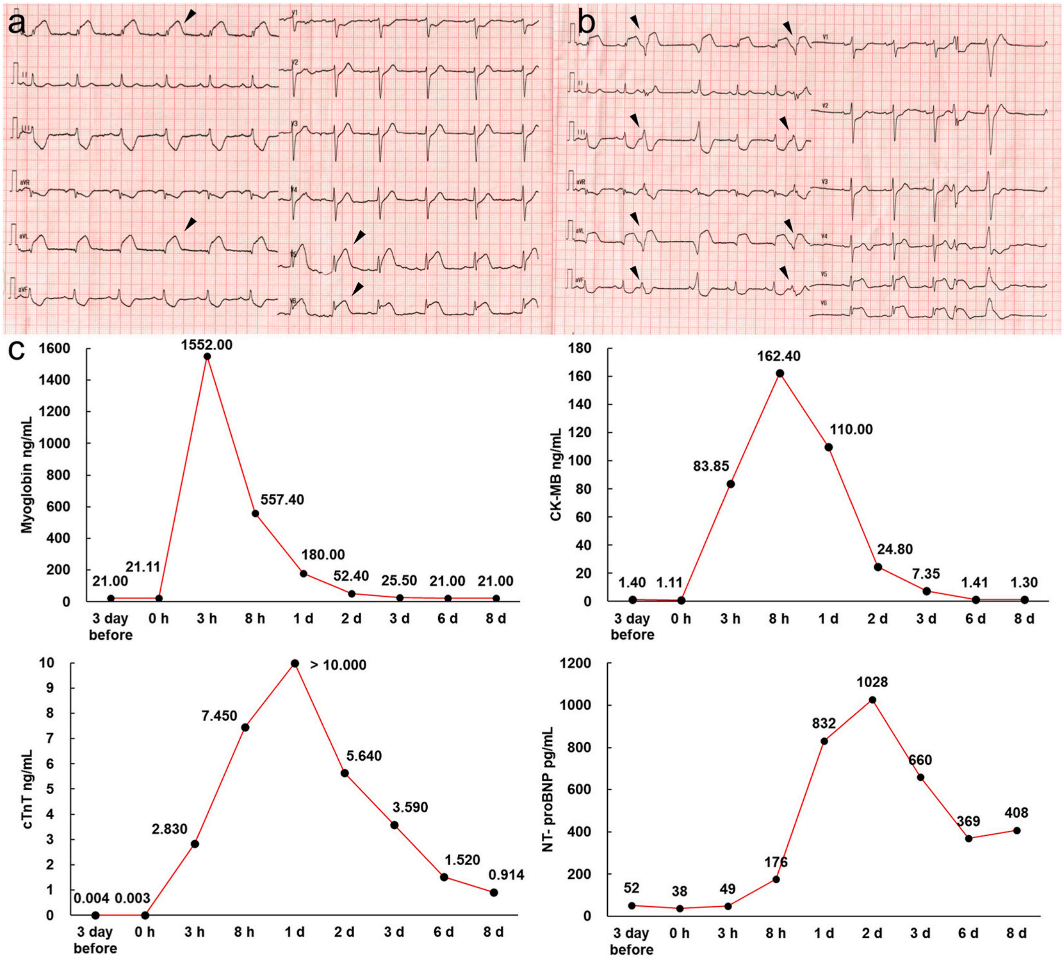

Fig. 2. a: Sinus rhythm, ST segment elevation in leads I, aVL, V5, and V6 with reciprocal ST segment depression. b: Ventricular premature beats with R-on-T phenomena. c: The level of cardiac troponin T (cTnT) increased to >10.000 ng/mL; the level of creatine kinase MB (CK-MB) increased to 162.40 ng/mL.

Mg^{2+}, diluted with 5% glucose and sodium chloride 500 mL, intravenous drip) was administered to support the electrolyte balance and prevent malignant arrhythmia.

Subsequently, coronary angiography was performed to evaluate possible coronary artery air embolism. Slow blood flow was observed in the left coronary artery. Plaques with mild stenosis in the left anterior descending artery (LAD) and plaques with minimal stenosis in the left circumflex artery (LCx) and right coronary artery (RCA) were detected. No obvious obstruction was observed (Fig. 1 j-l and supplementary materials). After angiography, the patient was transferred to ICU for further treatment. Ventricular premature complex and R-on-T phenomena were detected in the 12-leads ECG (Fig. 2b), magnesium sulfate (250 mg/h, continuous Intravenous infusion) and isosorbide dinitrate (2 mg/h, continuous intravenous infusion) were administered to prevent malignant arrhythmia and expand the coronary artery. Bedside echocardiography revealed left ventricular systolic dysfunction and regional wall motion abnormalities. The level of cardiac troponin T (cTnT) increased to >10.000 ng/mL, and the level of creatine kinase MB (CK-MB) increased to 162.40 ng/mL (Fig. 2c). The symptoms were gradually relieved over the next 3 days, and the 12-lead ECG and laboratory indices returned to normal. The newly discovered pulmonary nodule was diagnosed as hypertrophic fibrous connective tissue, and the patient was discharged on day 10 without cardiac or neurological sequelae.

3. Discussion

Systemic air embolism is a fatal complication of CT-guided percutaneous lung biopsy. Two main possible mechanisms and some potential risk factors of arterial air embolism in lung biopsy are proposed to date. First, the puncture needle enters the pulmonary veins and establishes direct commutation with the atmosphere, thus, external air could directly enter the lower pressure pulmonary veins; second, a fistula between the pulmonary veins and air cavity, such as the bronchus or alveolus, is created by the needle during the puncture process. Positive end-expiratory pressure ventilation, prone position, and the use of large size needle are considered to be risk factors during the biopsy procedure; maneuvers such as cough and Valsalva maneuver are considered potential risk factors for developing this complication by increasing intrapulmonary pressure aggravate air entry into pulmonary veins; basic lung diseases such as chronic obstructive pulmonary disease, pneumonia and cavitary or cystic lesions also increase the possibility of air entering pulmonary veins [3,10–13].

In our case, patient presented with dyspnea, cough and chest pain, treating physician ordered CT scan to R/O possible complications which was confirmed systemic air embolism (Fig. 1 d-i). Subsequently, the patient was placed in the Trendelenburg position. Previous research has shown that the Trendelenburg position has no significant effect on preventing bubbles in arteries from reaching the brain [14–16]; however, many physicians still place the patient in this position empirically in clinical practice [17–24], and a recent analysis seems to indicate a good prognosis of patients in the Trendelenburg position in the treatment of symptomatic air embolism. This approach is controversial but still worth considering; complications, including airway edema and cerebral edema, need to be controlled [3,4,25,26]. In addition, 100% oxygen and hyperbaric oxygen therapies are highly recommended for reducing air bubble volume and promoting gas absorption [27,28]. In our case, we provided the patient with 100% high-flow oxygen intake according to standard practice, and no obvious symptoms of hypoxia occurred.

Considering that the 12-lead ECG suggested myocardial ischemia in our patient (Fig. 2a), we performed coronary angiography trying to dispose potential air emboli and restore blood flow (Fig. 1 j-l). No severe stenosis or obvious obstruction were observed in the coronary artery, which excludes common causes of acute coronary syndrome and points to an air embolism. Three main possible mechanisms of ischemia caused by air emboli in the artery have been proposed in previous studies: direct obstruction of blood flow, initiation of vasospasm, and activation of platelets with microthrombus formation [10]. Operations, including coronary aspiration and injection of vasodilators, have been reported in previous practice during coronary angiography to restore blood flow in air embolism event [6,7]. We hypothesized that the air emboli in the coronary artery could be extruded or pushed to the distal artery by rapid injection of iodinated contrast media to restore the blood flow in the main arteries since the density of iodinated contrast media is higher than that of blood [29]; besides, large air bubbles could be broken into smaller ones during the insertion of the guidewire into the coronary artery, helping to restore the main blood flow and promote air absorption. Further experiments are required to explore the effects of the guidewire and contrast media on-air emboli in coronary artery hemodynamics during angiography.

Despite experiencing a dangerous incident, our patient gradually recovered within the next 10 days of supportive treatment, and no obvious neurological or cardiac sequelae were observed. However, many patients with coronary artery air embolism still cannot survive after treatment [12,30], and this case report cannot provide enough evidence to support treatment efficacy or failure. According to previous studies, measures have been suggested to prevent air embolism events in CT-guided percutaneous lung biopsy; avoid the use of endotracheal anesthesia and positive end-expiratory pressure ventilation; occlude the biopsy needle timely instead of prolonged opening; advice patient to avoid deep breathing or coughing during the procedure and use antitussives when necessary, position the lesion below the level of the left atrium and avoid an upright or semi-upright position, and avoid the biopsy of aerated lung tissue [3,5,11,12,20]. Physicians should be vigilant of this situation and take necessary measures during the process.

4. Conclusion

In summary, a coronary artery air embolism is a rare but life-threatening event that occurs during a CT-guided percutaneous lung biopsy, and an immediate CT scan can detect this situation promptly. The Trendelenburg position and coronary angiography are worth considering in treating arterial air embolisms. Therefore, adequate measures should be taken to prevent this.

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e27914

Ethics statement

This research has been approved by the Ethics Committee and Institutional Review Board of Chinese Academy of Medical Sciences & Peking Union Medical College, China. All procedures comply with the Declaration of Helsinki. The authors confirm that the patient has signed the informed consent form for the publication of the anonymized case details and images.

Data availability statement

The data associated with this study are not been deposited into a publicly available repository. The authors confirm that all the data of this study are available within the article and supplementary materials.

CRediT authorship contribution statement

Haotian Lu: Writing – review & editing, Writing – original draft, Investigation. **Jieqiong Yu:** Writing – review & editing, Writing – original draft, Investigation. **Hongliang Sun:** Writing – review & editing, Formal analysis, Data curation. **Shengtao Yan:** Writing – review & editing, Validation, Supervision, Resources, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e27914.

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