Case Report

International Journal of Clinical and Medical Case Reports

# Case Report: Cerebral Air Embolism After Transthoracic Needle Lung Biopsy

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**Received Date:** 29 Mar 2023
**Accepted date:** 25 Apr 2023
**Published Date:** 02 May 2023

**1. Abstract**

Cerebral air embolism is an uncommon, but high morbidity and mortality, event that can be complicated from many medical procedures, including cardiac surgery, venous and arterial access, laparoscopic surgery, or from trauma. Transthoracic needle biopsy is also another diagnostic intervention that can causing this event. Even though risk of air emboli is low, 0.2-0.4%, but its mortality rate is as high as 26%. Clinical presentation can mimic other stroke syndromes but had different mainstay of treatment, not antiplatelet but oxygen therapy.

We report case a 64 years old male suddenly develop confusion and left hemiparesis after doing transthoracic needle lung biopsy. Computer scan (CT) brain imaging show air in the brain parenchyma and along sulcus and gyrus. Oxygen therapy was started as soon as he was diagnosed. Transthoracic echocardiogram with agitated saline was done to evaluate other causes of stroke.

This uncommon causes of stroke should always be kept in mind when sudden onset of neurological symptoms occurs in patient who had been through procedure at risk of this complications. CT scan is imaging technique of choice, allowing to detect air bubble, more easily than magnetic resonance imaging (MRI).

**2. Keywords:**
Cerebral air embolism, embolic stroke, non-thrombotic stroke, transthoracic needle lung biopsy

**3. Background**

Stroke is very common in clinical practices and is globally second leading causes of death and second most common causes of disability [1]. There are two subtypes of stroke, hemorrhage or ischemia, which each subtype had different causes, clinical presentations, clinical courses, treatment strategies, and outcomes [2]. In recent global epidemiology of stroke, ischemic stroke contributes to 62.4% of all incident of strokes while intracerebral hemorrhage constituted 27.9% and subarachnoid hemorrhage constituted 9.7% [1]. The widely use classification systems for ischemic stroke is Trial of Org 10172 in Acute Stroke Treatment (TOAST) which had good interobserver agreement [3]. TOAST system attempts to classify ischemic stroke according to cause-related mechanism, such as large artery atherosclerosis, cardioembolism, small vessel occlusion, etc. Because of advancement in stroke evaluation and imaging there is refinement of TOAST classification called Causative Classification System (CSS) [4]. Even though stroke is common, some causes are unusual such as arterial dissection, cancer-related coagulopathy, or intrinsic disease of arterial wall [5]. Cerebral air embolism is another rare and uncommon cause of stroke with poor prognosis. The incidence is 2.65/100,000 hospitalizations/year, but it's probably underestimated due to undiagnosed [6]. Here we reported the case of cerebral air embolism after transthoracic needle biopsy with complete recovery of neurological symptoms.

**4. Case Presentation**

We presented the case of 64 years old male, 40 pack year active smoker, with history of hypertension and poor control of diabetes mellitus who came to Chest Center for further management of lung nodules and pleural effusion. His pleural effusion had been examined but couldn't point out the cause of problems, so fiberoptic bronchoscope was done and bronchoalveolar lavage was sent for analysis. Tuberculosis was suspected and antituberculosis medications were prescribed. After six weeks of treatment, no change in either nodule or effusion so pulmonologist suggest to do biopsy and interventionist was consulted for procedure, computer scan (CT)-guided transthoracic needle lung biopsy.

After biopsy was done for second times, planned for five times to get enough tissue, patient suddenly developed eye deviation to the right with left arm weakness. Even though he still alerts, he seems confused and could follow command occasionally. So, procedure was stop and he was sent to do CT brain imaging which show no hemorrhage or large territorial infarction. Neurologist was consulted for suspicious of stroke. Physical exam found left hemiparesis (Medical Research Council, MRC, scale grade 0) with hypotonia, left facial palsy, dysarthric speech, gaze preference to the right, and hyporeflexia on left side. Stroke fast track was

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activated and patient was sent to do magnetic resonance imaging (MRI) stroke protocol. His MRI didn't show any infarction, hemorrhage, or other abnormality that accounted for his symptoms (Figure 1) but clinical was fit in with stroke so he was moved to stroke unit.

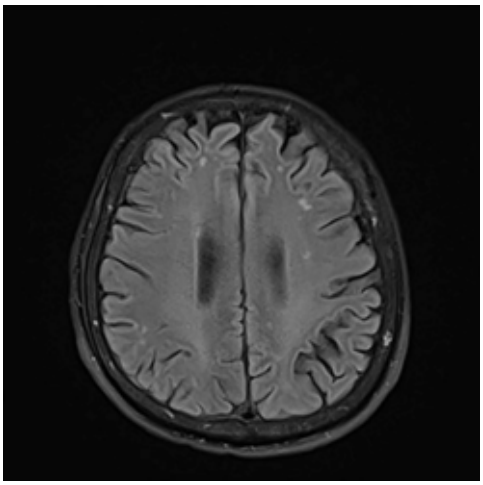

**Figure 1:** MRI brain imaging show no infarction, hemorrhage, or brain swelling in any area

After reviewing his CT and MRI brain imaging by neurologist and neuroradiologist, there were multiple, scattered, round-shaped, hypodensity lesion at right corona radiata and hypodensity lesion along sulci and gyri in right high frontal area in CT imaging (Figure 2-4). So, cerebral air embolism from transthoracic biopsy was diagnosed.

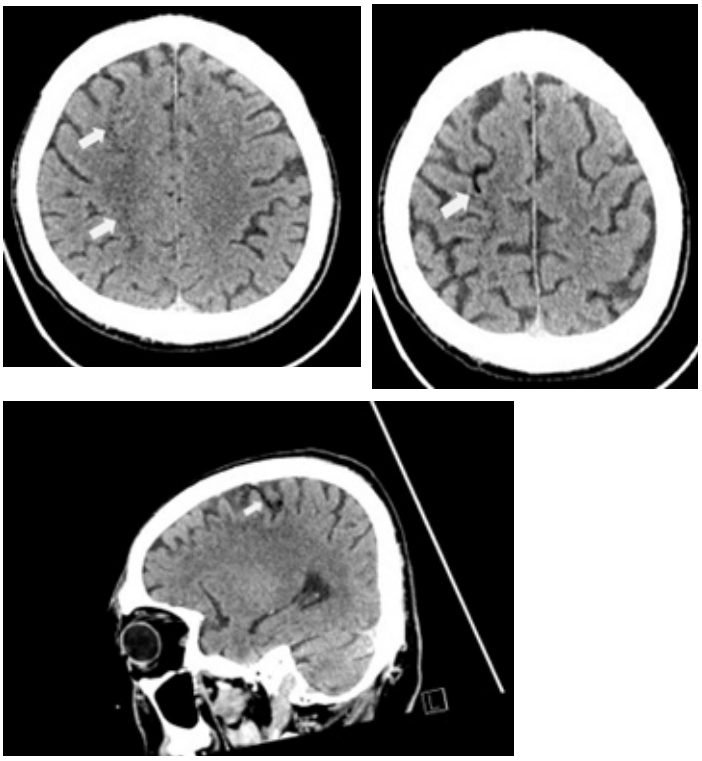

**Figure 2-4:** CT brain imaging show multiple round-shaped hypodensity lesion scattered in right corona radiata area and along sulcus and gyrus in right high frontal region

Due to risk of pneumothorax from recent transthoracic biopsy track, hyperbaric oxygen therapy couldn't be performed. Oxygen support using mask with bag, 10 Liter/min, was given and physical therapy program for left side weakness and dysarthria was started. Echocardiogram with saline agitation test and carotid doppler ultrasound were done for evaluation and both tests show normal results. His motor power start to improve after treatment for 8 hours and his neurological symptoms completely recovered in 1 day. CT brain imaging was repeated at 48 hours after onset (Figure 5) which show complete resolution of air bubble. Later on, patient was discharge after hospitalized for 72 hours without any recurrent of neurological symptoms.

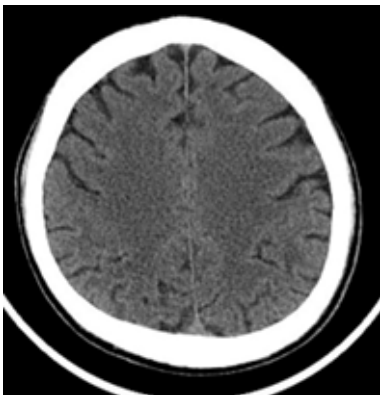

**Figure 5:** CT brain imaging at 48 hours after onset of neurological symptoms show complete resolution of air bubble in right corona radiata area

**5. Discussion**

Air embolism is a rare event in which air enter into the bloodstream causing symptoms from obstruct blood flow, breakdown blood-brain barrier, and also induces inflammatory reaction. Cardiovascular, pulmonary, and central nervous systems may all be affected, with severity ranging from no symptoms to cardiovascular collapse. Cardiac manifestation includes chest pain, mill-wheel murmur, and electrocardiography (EKG) evidence of non-specific ST-T change. Pulmonary symptoms such as dyspnea, tachypnea, or hypoxemia can be found, and neurological symptoms of air embolism are seizures, encephalopathy, and ischemic infarction with focal neurological deficits [7]. Central venous catheter manipulation is most common situation associated with cerebral air embolism [8, 9]. Other conditions, such as neurosurgical or invasive surgical procedure, penetrating injuries and barotrauma, or cardiothoracic surgery with cardiac bypass can also causing cerebral air embolism [10-12].

Transthoracic needle lung biopsy is commonly performed diagnostic procedure for lung nodule or mass. The most common complications are pneumothorax and hemorrhage [13]. Tumor seeding along needle biopsy

tract is rare complication that can occur but didn't affect survival or disease staging [14]. The even more infrequent complication than tumor seeding but more serious outcome, 26% mortality rate, is air embolism. The report risk of air embolism after transthoracic needle biopsy is 0.2-0.4%. Other outcome of air embolism are paresis (53%) and cardiac complication (37%) [15]. Risk factors for air embolism from procedure are penetration depth into the tumor, endotracheal anesthesia, level of the lesion above left atrium, prone positioning, or number of biopsy samples [16]. It's can explained by the fact that the higher lesion above left atrium, the lower pulmonary venous pressure which meant greater risk of air inflow to vessel if had vascular wall damage. This also can explain why risk is higher when doing procedure in prone position too [16].

For diagnosis of cerebral air embolism, due to its uncommon etiology of stroke, clinician should have high index of suspicious in patient who develop sudden neurological deterioration after manipulation of central venous catheter, certain neurological procedures like posterior fossa surgery in sitting position, or any procedure that had risk of air entering blood vessel, such as in our case. [8, 17]. Then confirmation of intracranial air should be done by brain imaging, preferably non-contrast CT scan because of its high sensitivity for detection. Scan should be done within first hour after symptoms onset, owing to rapid absorption of air by brain arterioles. Late examination of scan can lead to false-negative result [18]. In CT scan, air bubbles can be detected in intraparenchymal, intracranial vasculature, or curvilinear hypodensity close to cortical sulci [9]. Magnetic Resonance Imaging (MRI) brain scan had less both sensitivity and specificity compare to CT because intracranial air bubble can be mistaken for blood products or cortical vessels due to its low magnetic susceptibility. Even though there are some reports using MRI gradient-echo image (GRE) sequence to visualized intracranial air emboli, but most common findings in other image sequences are non-specific [19,20]. Treatment of cerebral air embolism is adjusting patient's position to left lateral and Trendelenburg decubitus with adequate oxygenation. Nitrogen content of bubbles will be reduced by 100% oxygen therapy which enhancing resorption of bubbles from vascular system [21]. Hyperbaric oxygen therapy (HBOT) should be initiated as soon as possible, preferably 4-6 hours after onset. HBOT can reduce the size of bubbles by increasing ambient pressure and reduce amount of air by increasing hyperoxygenation [22, 23]. In our case, we couldn't do HBOT treatment because of high risk of pneumothorax from recent procedure, percutaneous transthoracic needle biopsy. In general, contraindications of HBOT are untreated pneumothorax, ratio between partial pressure of oxygen and fraction of inspired oxygen ($PaO_2/FiO_2$) < 200, and generalized epileptic status [24]. So, only oxygenation and intravenous fluid were given in our patient. His clinical slowly improves and after 24 hours from onset, his neurological symptoms were completely disappeared.

Prognosis of cerebral air embolism depend on many factors, such as procedure that causing emboli, delayed in diagnosis and treatment, or amount of air bubbles. About HBOT, there is variable prognosis of patient receiving therapy. In one case series, sixteen patients, outcomes after HBOT were 50% had complete recovery, 31% had partial relief, 19% had no benefit, and death in 12.5% of patients [25]. In some case report or case series, prognosis still good even though they didn't get HBOT due to multiple contraindications [23,26]. So, early detection with prompt management is essential key for better prognosis and HBOT should always be considered if there are no contraindications.

## 6. Conclusion

Cerebral air embolism is an uncommon cause of ischemic stroke with high morbidity and mortality. This condition should be considered in patient that develop acute onset neurological symptoms after procedure at risk. Neuroimaging that best detect the air is CT brain, MRI is primarily used to evaluate infarction area rather than detection the air. Neurologists and stroke specialist physicians should be aware of this condition in order to promptly recognize and management.

## 7. Ethics Approval And Consent To Participate

The protocol for this study was approved by the Bangkok Hospital Institutional Review Board of Bangkok Hospital, Bangkok, Thailand (COE 2023-01). Written informed consent was not obtained from study participants due to our study's case report with anonymity-preserving design. The ethics committee that waivered the need for informed consent was also Bangkok Hospital Institutional Review Board of Bangkok Hospital, Bangkok, Thailand. All authors confirm that the research was conducted in accordance with the Declaration of Helsinki.

## 8. Acknowledgements

We are thankful of Dr. Pimon Ruttanaumpawan, who is chest specialist and primary physician of patient. We also thankful for the help of radiologist from radiology department, stroke team, and physical therapy team.

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