In-flight Seizures and Fatal Air Embolism

The Importance of a Chest Radiograph

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Objective: To describe for the first time, to our knowledge, a case of recurrent in-flight–dependent seizures related to commercial airline flight in which the patient experienced a fatal air embolism secondary to a giant bronchogenic cyst.

Design: Case report.

Setting: University hospital.

Patient: A female airline passenger presented with a seizure, then unconsciousness and death. The patient had experienced 2 previous episodes of in-flight seizures without any sequelae.

Results: The patient had an air embolism proved by findings on cranial computed tomography (CT) and a CT perfusion study. The embolism was secondary to a giant bronchogenic cyst that was evident on chest CT. The patient was examined after the previous episodes of in-flight seizures, but no chest radiography had been performed.

Conclusions: We propose minor air embolism as a cause of in-flight seizures. This type of seizure can signify the existence of a giant bronchogenic cyst. We believe that obtaining a chest radiograph can be useful in patients with a history of in-flight seizures to rule out the presence of a bronchogenic cyst and to prevent a possibly fatal air embolism.

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IN-FLIGHT SEIZURE IS A RARE MEDICAL emergency that has been related to sleep loss and sleep disruption in patients already diagnosed as having epilepsy. However, to our knowledge, there has never been a reported case of exclusively in-flight–dependent seizures. We present a case of fatal air embolism during a commercial flight in a patient with a bronchogenic cyst, including a review of her imaging findings. She had a history of recurrent in-flight seizures, probably caused by minor gas embolism. We discuss the utility of chest radiography to rule out a pulmonary cyst in patients with a history of in-flight seizures. We also analyze the imaging findings of this case, especially the findings of the cranial computed tomography (CT), including perfusion and minimum intensity projection (MinIP) reconstructions.

REPORT OF A CASE

A 52-year-old woman who was a passenger on a commercial airliner (Boeing 737; Boeing, Chicago, Illinois) experienced a sudden episode of dyspnea and a 5-minute generalized tonic-clonic seizure followed by loss of consciousness. The patient was admitted to our hospital 2 hours later with a Glasgow coma score of 5 and was then intubated. Laboratory data were unremarkable.

The patient had experienced 2 previous episodes of seizures, each occurring during a commercial airline flight, that were studied in the neurology department. She had never experienced a seizure unrelated to an airline flight. Neurologic studies performed for the previous seizures included sleep electroencephalography and cranial magnetic resonance imaging (MRI). The results of sleep electroencephalography demonstrated a focal left temporal seizure that occurred during hyperventilation. The MRI was unremarkable, and treatment with oxcarbazepine was initiated.

After the third seizure, cranial CT was performed at the emergency department and showed several small corticosubcortical gas emboli and subtle effacement of the right hemispheric sulci (Figure 1A). The MinIP reconstructions allowed better visualization of the gas emboli (Figure 1B). Findings on CT angiography were normal, and a CT perfusion study...
showed bilateral patchy areas of hypoperfusion located in the left frontal and left temporoparietal parenchyma with decreased mean transit time (Figure 1C), decreased cerebral blood flow, and normal cerebral blood volume. Because of these findings, the patient was transferred to the hyperbaric oxygen unit.

After recompression therapy, she was admitted to the intensive care unit and a chest radiograph was obtained. The radiograph demonstrated a large intrapulmonary cyst on the right side. A thoracic CT performed 6 hours later demonstrated a large bronchogenic cyst on the right side with an air-fluid level (Figure 2). In addition, a new cranial CT showed multiple bilateral hypodense areas in the left internal capsule, right frontal lobe, and temporal white matter but no gas bubbles. An inferior myocardial infarction was also noted.
A third cranial CT performed 12 hours later showed bilateral hypodense areas in the basal ganglia and both cerebral hemispheres with midline herniation and sulcal effacement (Figure 1D). No further hyperbaric oxygen treatment was performed. The patient experienced progressive neurologic deterioration and died 4 days later.

**COMMENT**

Approximately 1 in every 39,000 airline passengers presents with an in-flight medical emergency, and about 6% of these are seizures. Patients with epilepsy have shown an increase in seizures during the first few days after a flight. Sleep disruption and sleep loss, rather than hypoxia related to being in a pressurized cabin, are thought to be the origin of this increase. The current Aerospace Medical Association guidelines state that most patients with epilepsy can fly safely.

Bronchogenic cysts, although relatively rare (prevalence, 1 in 42,000 to 1 in 68,000 people), represent the most common cystic lesion of the mediastinum. Bronchogenic cysts result from anomalous budding of the ventral foregut between the 26th and 40th week of gestation. They are usually single but may be multiple and can be filled with fluid or mucus. Most of them are filled with fluid or mucus; only 5.8% of cysts present with air or air-fluid filling.

Normal sea-level barometric pressure is 1 atm (760 mm Hg). At cruising altitudes of 11,582 m, a Boeing 737 commercial airliner is pressurized to maintain a cabin pressure of approximately 0.75 atm (570 mm Hg), which is equivalent to an altitude of 2438 m. Based on the Boyle-Mariotte law (pressure × volume = constant), any decrease in ambient pressure induces an increase in the volume of gas in a noncommunicating space. In an air-filled bronchogenic cyst, assuming that the vestigial communication between the bronchial tree and the cyst was obliterated, the decrease in ambient pressure during the climb of the aircraft can result in expansion of the cyst volume. Depending on the compliance of the cyst, subsequent tears of the cyst wall can lead to leakage and discharge of the intracystic air into the surrounding vessels; bubbles of gas are then directly distributed to all organs. Hyperbaric therapy is considered the most effective first-line treatment and should be instituted as early as possible, even for patients in extremely poor condition. Hyperbaric therapy causes a reduction in bubble volume according to the Boyle-Mariotte law.

Small emboli in muscles or viscera are clinically unnoticed, whereas cerebral or coronary localizations may result in severe clinical manifestations. Bubbles of gas in the arterial vessels can lead to local ischemia and edema due to the absence of blood. In the brain, the interface between gas bubbles and the endothelium engenders a local inflammatory response, possibly disrupting the blood-brain barrier, worsening edema, and further impairing cerebral perfusion. This disruption explains why the main initial clinical manifestations are neurologic symptoms, regardless of whether these symptoms are associated with circulatory disorders.

Gas in the cerebral circulation is uncommon, but it can be seen after surgical procedures, trauma, intravenous catheterization, infection, and gas embolism. Computed tomography may show small air bubbles in the early studies of a cerebral air embolism. Air bubbles may not be visualized if the volume of the gas emboli is not large enough. In our case, the first CT showed many air bubbles with a typical subcortical embolic distribution, probably related to a massive volume of embolized gas. MinIP reconstructions tend to enhance air spaces. Thus, this type of reconstruction may be useful to improve the visualization of small gas bubbles in the brain. In addition, a CT perfusion study was performed because it is well recognized as a useful technique for detecting acute cerebral ischemia in acute strokes. The CT perfusion study results confirmed the presence of ischemic areas with altered mean transit times secondary to the gas embolism. After the recompression therapy, changes seen on CT were nonspecific, presenting with diffuse edema but without clear focal hypodensities, probably because ischemia was diffuse and the injured areas were small. These findings are consist with MRI reports in decompression sick-
ness showing multiple punctate nonenhancing foci of prolonged relaxation times in subcortical white matter. Magnetic resonance imaging was not performed in the acute setting in this case, as CT is considered our first option in acute stroke because of its rapid availability, which can save time before subsequent emergency decompression therapy. In addition, air is more difficult to detect on MRIs than on CTs. Droghetti et al\(^1\) reported that an MRI obtained immediately after the onset of symptoms following gas embolism showed normal findings.

Our case represents an air embolism secondary to a giant bronchogenic cyst that presented with a seizure and was followed by coma and death. Our patient had experienced seizures during 2 previous flights but had experienced no other nonflight-related seizures. The 2 previous seizures probably had been caused by minor air embolism from the giant bronchogenic cyst. After the first seizure, the patient underwent examination that included an unremarkable cranial MRI. No chest radiography was performed, and the pulmonary cyst was never assessed. However, an electroencephalograph showed focal seizures. These changes were observed only during an episode of hyperventilation that probably caused a minor air embolism secondary to a change in the pressure of her cyst.

In-flight seizure with a fatal air embolism stroke in an airline passenger with a pulmonary bronchogenic cyst has been reported once before\(^1\) in a patient who had no history of in-flight seizures. In addition, air embolism as a complication of intrapulmonary bronchogenic cysts has been reported in scuba divers\(^1\) and in construction workers in a pressurized tunnel.\(^1\)

Based on the findings of the British Thoracic Society Standards of Care Committee,\(^2\) adults with a history of air travel intolerance who experience respiratory symptoms (eg, dyspnea, chest pain, confusion, and syncope) and patients with conditions worsened by hypoxemia (eg, cerebrovascular disease, coronary artery disease, and heart failure) should undergo preflight assessment. In addition, we suggest that chest radiography be performed to rule out a bronchogenic cyst in any seizure related to an underpressurized environment. Because of the unpredictable long-term prognosis of bronchogenic cysts in adults, these cysts should be surgically resected whenever they are operable.\(^1\) Patients who are not candidates for surgical resection or who decline surgery should be cautioned to abstain from activities leading to considerable changes in ambient pressure, such as flying, diving, and high-altitude climbing, to avoid a fatal air embolism.

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