Iatrogenic pneumocephalus secondary to intravenous catheterization

Case report

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The presence of pneumocephalus in a patient without a history of undergoing intracranial or intrathecal procedures is a significant radiographic finding that portends a violation of the dural barrier or the presence of infection. The authors report a case of iatrogenic pneumocephalus that confounded the evaluation of a patient with unrelated neurological disorders, resulting in unnecessary transfer of the patient and utilization of medical resources. A review of 100 sequential computerized tomography scans obtained in patients for any indication in the emergency department revealed a 6% incidence of iatrogenic intravenous pneumocephalus. Computerized tomography scans revealing pneumocephalus had been obtained for altered mental status, local motor deficit, seizure, and trauma. More careful intravenous catheterization and recognition of the condition on imaging may avoid similar problems.

KEY WORDS • iatrogenic complication • pneumocephalus • neuroradiology

T he presence of pneumocephalus (“air in the head”) in a patient without a history of undergoing intracranial or intrathecal procedures is a significant radiographic finding that portends a violation of the dural barrier or the presence of infection. When unexplained pneumocephalus is visualized on computerized tomography (CT) scanning, a thorough search for its cause must be pursued. We describe a case of iatrogenic intravascular pneumocephalus that confounded the evaluation and treatment of a patient. To determine the incidence of this radiographic finding, we performed a prospective analysis of 100 CT scans. We review our case and the differential diagnosis of pneumocephalus.

Case Report

History. This 54-year-old woman with a history of a cystic craniopharyngioma that had been resected 10 years earlier presented to a referring emergency department with a 1-month history of slowly progressive confusion. The patient had a significant medical history that included insulin-dependent diabetes mellitus, seizures, and major depression. The patient’s sister reported that the patient had had a seizure 7 weeks prior to presentation, but otherwise her condition had been well controlled with 800 mg carbamazepine administered daily. The patient had fallen on ice approximately 1 week before presentation and had been evaluated at her local emergency department and found to have several superficial extremity contusions and a scalp contusion. On the day of admission, the patient’s neighbors found her wandering the halls of her apartment building in a confused state. She was transported by ambulance to her regional emergency department.

Examination. On examination the patient was afebrile with normal vital signs. She was awake and alert but oriented only to person. Her mood fluctuated between somnolence and agitation. Her pupils were 4 mm bilaterally with a left afferent pupillary defect and blindness of the left eye. The third through 12th cranial nerves were intact. The patient had generalized weakness without a focal motor deficit. Sensation was intact bilaterally. There was no dysmetria or nystagmus. Her reflexes were normal and symmetrical bilaterally. There was no meningismus and no carotid bruits. The cardiopulmonary and gastrointestinal examinations were normal.

A peripheral intravenous catheter was placed, the patient’s metabolic status was evaluated, and CT scanning of the head was performed. Laboratory findings, including glucose, sodium, and carbamazepine levels and peripheral leukocyte count, were normal. The CT scans revealed pneumocephalus in the cavernous sinus and superior sagittal sinus. There was no evidence of subarachnoid hemorrhage, subdural or epidural hematoma, or a skull fracture (Fig. 1).

The patient was transferred to the emergency depart-
Iatrogenic pneumocephalus

Discussion

Definition and Differential Diagnosis

The term “pneumocephalus” means air in the head. To most neurosurgeons, it implies air in the ventricle, subarachnoid, subdural, or epidural spaces. It is also possible to have intravascular air as a manifestation of pneumocephalus. The presence of pneumocephalus is of concern to the clinician, because it indicates that the protective barriers of the brain have been violated. If bacteria are not producing the air, this finding suggests that CSF is being exchanged for air, possibly allowing the introduction of bacteria. Intracranial air emboli are associated with carotid endarterectomy, but do not lead to strokes. Intravascular intracranial air may be of lesser neurosurgical concern compared with air in other compartments, but the location and cause of intracranial air need to be examined by the clinician. Patients with pneumocephalus may present with headache, nausea, vomiting, seizures, dizziness, or obtundation.

The occurrence of pneumocephalus following a neurosurgical procedure is common. The risk of tension pneumocephalus due to nitrogen in the anesthetic gas is well appreciated by neurosurgeons and anesthesiologists.5,6 The differential diagnosis of pneumocephalus in the patient who has not undergone surgery includes trauma with significant basilar skull fractures, congenital skull defects, neoplasm, barotrauma, and anaerobic infection. We would add to this list iatrogenic intravascular infusion (Table 1). Pneumocephalus following trauma is diagnostic of a basilar skull fracture when no open fracture of the skull is present. The patient described here has a vague history of trauma, but a review of emergency department records showed that there was no loss of consciousness and only a small scalp contusion. It is unlikely that the force of her fall on the ice led to a basilar skull fracture and none was detected on CT scanning or suggested by the physical examination. Erosion of the skull by tumors, including craniopharyngioma, may also allow the introduction of air as well as infection, but there was no evidence of a CSF fis-

**TABLE 1**

<table>
<thead>
<tr>
<th>Causes of pneumocephalus</th>
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<tbody>
<tr>
<td>postintrathecal procedure</td>
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<tr>
<td>sinus fracture</td>
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<tr>
<td>open fracture</td>
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<tr>
<td>basilar skull fracture</td>
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<td>congenital skull defect</td>
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<tr>
<td>neoplasm</td>
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<tr>
<td>gas-producing organism</td>
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<tr>
<td>barotrauma</td>
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<td>iatrogenic intravascular infusion</td>
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tula or intracranial infection in our patient. Additionally, erosion of the skull base would not account for the intravascular location of the air.

In 1884, Chiari (as noted by various authors) first reported intracranial pneumocephalus with a frontal CSF fistula via the ethmoidal air cells. The first radiographic report of pneumocephalus due to trauma was made by Luckett in 1913. Pneumocephalus may occur in the subdural, epidural, intraparenchymal, or intraventricular spaces.

Computerized tomography scanning can easily detect small amounts of pneumocephalus. With a Hounsfield coefficient of −1000, the air appears black, darker than CSF. The density of fat appears similar to air, but has a Hounsfield coefficient of −100. Larger quantities of air can be detected on plain x-ray films. Small amounts of air around the skull base and clinoids must be distinguished from pneumatized bone. This is best appreciated with finely cut CT bone windows.

Incidence of Intravascular Pneumocephalus

To determine the incidence of iatrogenic intravascular pneumocephalus, we evaluated 100 sequential CT scans obtained from the emergency department. All patients had peripheral intravenous catheters that had been placed while they were in the emergency department or during transportation to the hospital by emergency medical services. The CT scans were obtained for a variety of indications including trauma, neurological deficit, and headache.

Six of the 100 scans revealed intravascular pneumocephalus. The indications for the six patients with CT scans demonstrating intracranial intravascular air included altered mental status in three and focal motor deficit, seizure, and trauma in one each. Air was detected in the cavernous sinus in four patients and in the torcular and superior sagittal sinus in one patient each. No patient with pneumocephalus had experienced a traumatic vascular injury, an intrathecal procedure, or a skull fracture. Two neurosurgeons and a neuroradiologist confirmed all positive scans.

The mechanism of iatrogenic intravascular pneumocephalus may follow one of several pathways. We believe that air injected directly into the peripheral vascular system returns with the brachial and subclavian venous flow and then ascends in response to gravitational forces, moving against the venous outflow of the jugular veins into the intracranial compartment. It has been noted by one of our neurosurgeons that intravascular air can be visualized as it ascends the internal jugular vein during carotid endarterectomy (J King, personal communication, 1999). Imanishi, et al. reported several cases of iatrogenic pneumocephalus during cardiopulmonary resuscitation. They suggested that intravenous air was forced into the arterial system via a traumatic arteriovenous fistula caused by pulmonary barotrauma, as has been reported to occur with positive-pressure ventilation. It is also possible that injected air returns with the venous flow to the right atrium, is absorbed as it flows through the pulmonary capillaries, flows through cerebral capillary pathways, and then escapes as free air into the cerebral venous system, as occurs with barotrauma. We believe that this is unlikely to happen and that air ascends passively within the venous system to the highest point, the cerebral venous sinuses. In our case of pneumocephalus, we were surprised to find that the intravascular air persisted 3.5 hours later.

Although pneumocephalus is often a significant marker of a pathological condition, it is important to recognize the radiographic appearance, origin, and benign nature of intravascular pneumocephalus in the presence of intravenous catheterization. Intravascular pneumocephalus is different from intraparenchymal pneumocephalus. Recognition of this confounding finding will facilitate expedient medical care and identification of the patient’s underlying problem.

References


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