Spontaneous extensive pneumocephalous as a rare manifestation of *Escherichia coli* suppurative meningitis in Diabetic ketoacidosis

Abhishek Dhir, Swati Dahiya, Nidhi Bhardwaj, Monica Gupta

Department of General Medicine, Government Medical College and Hospital, Chandigarh, India

Correspondence to
Professor Monica Gupta;
monicamanish2001@gmail.com

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DESCRIPTION

Pneumocephalous is characterised by presence of air or gas in the cranial cavity and the majority of cases occurs secondary to a mechanical trauma to skull or neurosurgical intervention. Bacterial meningitis due to *Escherichia coli* is an extremely uncommon cause of extensive pneumocephalous in a middle aged adult. The pathophysiological mechanism, aetiological agents and radiological imaging study of this unusual entity are discussed.

A 36-year-old woman presented with high grade fever, vomiting, pain abdomen and altered sensorium for 1 week. There was no history of any recent head trauma or neurosurgical procedure or sinus surgery. On evaluation, patient was in altered sensorium with Glasgow Coma Scale of E4V4M5 and nuchal rigidity was present. Laboratory investigations revealed elevated total leucocyte count of $25 \times 10^9/L$, venous plasma glucose of 534 mg/dL, arterial blood gas suggestive of severe high anion gap metabolic acidosis and positive serum and urinary ketones. Serum electrolytes, renal and hepatic profile and chest radiograph were unremarkable.

CT head showed multiple specks of air in subarachnoid spaces of bilateral cerebral hemispheres and bilateral lateral ventricles suggestive of pneumocephalous (figure 1). Cerebrospinal fluid (CSF) analysis showed frank pus with thick coagulum (figure 2), therefore leucocyte count and biochemical estimations were not possible. CSF cytology showed 100% neutrophils and adenosine deaminase levels were 18. CSF gram staining showed gram negative bacilli, confirmed on culture to be *E. coli*. Acid fast stain and BACTEC for tuberculosis was negative in CSF. Patient was treated

Figure 2 Cerebrospinal fluid suggestive of thick pus.

Figure 1 Axial non-contrast CT images of head showing presence of multiple foci of air in the extra-axial cerebrospinal fluid spaces in the bilateral cerebral hemispheres and in the bilateral lateral ventricle.

with meropenem, amikacin and vancomycin, insulin infusion, intravenous fluids and ventilatory support. However she succumbed to the illness on day 3 due to refractory septic shock.

Intracranial air may be attributable to a breach in integrity of the cranial bone or dura, and may result from mechanical trauma or barotrauma, neurosurgical instrumentation or sinus surgery, air embolism or postradiation necrosis of skull appendages and brain abscess or infections due to gas forming organisms.¹ Intracranial infections produce gas by putrefaction secondary to autolysis of intracellular proteins and glucose decomposition, often in presence of tissue ischaemia. Markham reviewed 295 cases and demonstrated the aetiology of pneumocephalous as trauma in (73.9%), neoplasm (12.9%), infections (8.8%) and neurosurgical intervention in 3.7% cases.² Supportive organisms responsible for pneumocephalous comprise species of *Escherichia*, *Klebsiella*, *Peptostreptococcus*, *Bacteroides*, *Fusobacterium*, *Clostridium*, *Streptococcus* and mixed facultative and anaerobic species.³

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Images in...

Patient's perspective

We were not aware of the deranged plasma sugars and the fact that meningitis with air inside the brain can affect my wife's condition to such an extent was devastating for me and my family.

Learning points

- ▶ Spontaneous pneumocephalus may occur as a rare life threatening complication of acute suppurative meningitis in diabetic ketoacidosis.
- ▶ Diagnosis of pneumocephalus is often straightforward on CT head, as it is highly sensitive in detecting air in the intracranial compartment. Early suspicion and appropriate antibiotic therapy may save the patient from neurological deterioration.

Clinically, it is important to differentiate simple from tension pneumocephalus which is air collection due to a ball-valve mechanism allowing air to enter the skull but prevents it from escaping, thus creating a pressure differential.⁴ CT is a highly accurate diagnostic tool and air has a Hounsfield coefficient of -1000 , which enables a sensitivity of as little as 0.5 mL of air in both extra-axial or intra-axial intracranial compartment.⁵ Air over the frontal convexities may appear as 'Mount Fuji sign', and multiple small air bubbles in several cisterns may show 'air bubble sign'.⁵ On MRI the diagnosis may be more difficult as there is no 'objective' density measurement.

Response to treatment depends on the age, clinical status, the extent and progression of the intracranial air, and the underlying aetiology.² Most cases of spontaneous pneumocephalus resolve with urgent antibiotics, supplemental O_2 and close monitoring. In fact, there have been cases in literature where children and

adult patients with meningitis associated spontaneous pneumocephalus have remarkably responded to prompt early antibiotic therapy, with complete radiological resolution of entrapped gas on a follow-up imaging 2 weeks later.^{1 6–10}

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ORCID iD

Monica Gupta <http://orcid.org/0000-0002-3992-1013>

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