



Concurrent Spontaneous Pneumocephalus and Subarachnoid Hemorrhage Due to *Klebsiella Pneumoniae* Meningitis

Eun Ji Lee
Rae On Kim
Mina Lee
Byung-Euk Joo

Department of Neurology,
Soonchunhyang University Seoul Hospital,
Soonchunhyang University
College of Medicine, Seoul, Korea

Dear Editor,

Pneumocephalus is the presence of air or gas within the cranial cavity,¹ and is usually caused by craniofacial trauma, neurosurgery, or an invasive procedure. Although rare, bacterial meningitis can lead to pneumocephalus without structural defect of the skull or dura.² In addition, subarachnoid hemorrhage (SAH) is extremely rare, although there are reports of cerebral infarction due to arteritis, thrombophlebitis, or vasospasm being accompanied with bacterial meningitis.³ Here we report an unusual case—which is the first case to the best of our knowledge—presenting concurrent pneumocephalus and SAH due to *Klebsiella pneumoniae* meningitis in adults.

A 51-year-old female was admitted to our hospital with right ear pain and headache that had first appeared 3 days previously. She had a 10-year history of diabetes mellitus (DM) and liver cirrhosis due to hepatitis C. At admission she had no fever and her consciousness was alert, but on the following day her consciousness deteriorated to stupor with a high fever of 38.9°C. A neurologic examination revealed neck stiffness, although her brainstem reflexes including the corneal reflex and vestibulo-ocular reflex were intact. The initial brain CT (computed tomography) showed right chronic otitis media (COM), but the findings were otherwise unremarkable (Fig. 1A). At 3 hours after the initial brain CT, she showed ocular flutter and absence of brainstem reflexes. Blood tests revealed thrombocytopenia (platelet count: 40,000/ μ L), but no leukocytosis or elevation of CRP. During the cerebrospinal fluid (CSF) study there was a high opening pressure of 510 mm H₂O, with the CSF presenting a greenish yellow color with the following extremely serious inflammatory findings: 14,200 white blood cells/ μ L (97% polymorphonuclear cells), 3,150 red blood cells/ μ L, elevated protein (1,740 mg/dL), and severe hypoglycorrachia (glucose ratio in CSF/serum=0.03). Vancomycin, meropenem, and ampicillin along with high doses of steroids were applied immediately after obtaining the CSF findings. Despite the combined antibiotic treatment, the patient deteriorated rapidly to a coma state with anisocoric pupils and no self-respiration. On the 3rd day of hospitalization, SAH in both cerebral sulci and the suprasellar cistern was observed on brain CT (Fig. 1B). Brain magnetic resonance angiography only revealed diffuse luminal irregularity in both middle cerebral arteries, with no aneurysm identified. She progressed to septic shock with high fever and decreased blood pressure. Chest and abdomen-pelvic CT produced no other infectious findings. However, *Klebsiella pneumoniae* was identified in blood and CSF cultures. Based on these results, cefepime (which is more effective against *Klebsiella pneumoniae*) was replaced as the main antibiotic treatment. However, her condition did not improve despite aggressive treatment. Brain CT of the 10th day (Fig. 1C) revealed pneumocephalus (which had not been seen previously) within subdural, intraparenchymal, and intravascular spaces, along with diffuse brain swelling. Unfortunately her condition continued to worsen, and she died on the 12th day.

Pneumocephalus is usually associated with craniofacial trauma, neurosurgery, or neo-

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Correspondence

Byung-Euk Joo, MD, PhD
Department of Neurology,
Soonchunhyang University
Seoul Hospital,
Soonchunhyang University
College of Medicine,
59 Daesagwan-ro, Yongsan-gu,
Seoul 04401, Korea
Tel +82-2-709-9224
Fax +82-2-710-3098
E-mail faithjoo17@gmail.com

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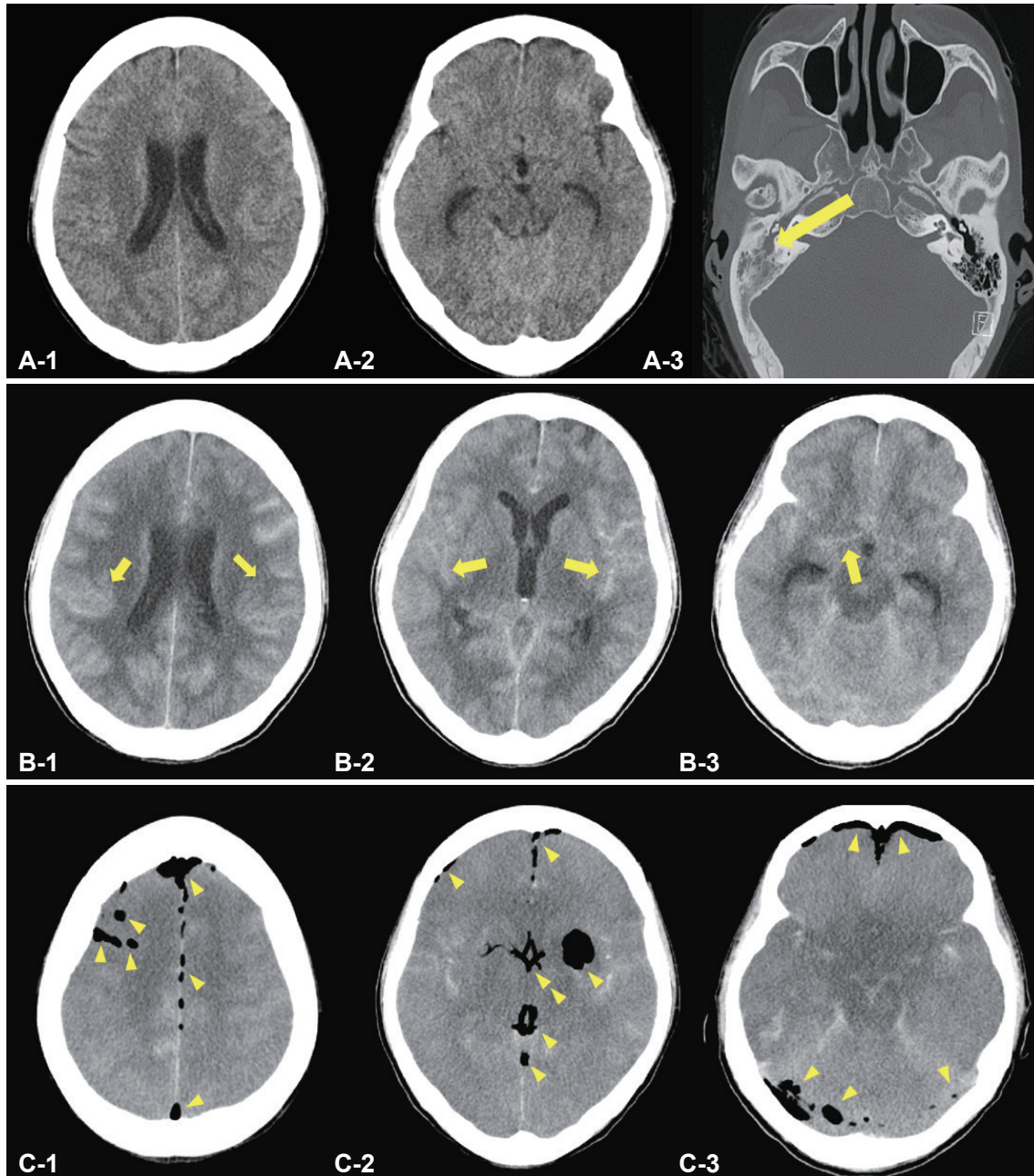


Fig. 1. Serial brain computed tomography (CT) was performed at the symptom onset day (A, B) and at 7 days after symptom onset (C). A: The initial CT images showed right chronic otitis media (long arrow) but were otherwise unremarkable. B: Subarachnoid hemorrhage (SAH) (short arrows) in both cerebral sulci (B-1, B-2) and the suprasellar cistern (B-3) was observed in 15-hour follow-up CT images. C: Diffuse brain swelling and pneumocephalus (arrowheads) within intravascular (C-1, C-2, C-3), subdural (C-1, C-2, C-3), intraparenchymal (C-2, C-3) spaces were observed in 7-day follow-up CT images.

plasms. Spontaneous pneumocephalus after bacterial meningitis is rare, and occurs when aerobic and anaerobic bacterial infections such as *Clostridium perfringens*, *Enterobacter coli*, and *Klebsiella aerogenes* produce gas by putrefaction through the autolysis of intracellular proteins and glucose decomposition.⁴ Since *Klebsiella* species are rare pathogens for adult bacterial meningitis, pneumocephalus after *Klebsiella pneumoniae*

meningitis is extremely uncommon. In bacterial meningitis, cerebrovascular complications are a determinant of unfavorable outcomes. Incidence rates of cerebrovascular complications of 4.6%–19.9% have been reported in bacterial meningitis, with cerebral infarction being the most common, and cerebral hemorrhagic complications such as SAH or intracranial hemorrhage are very rare, with reported incidence rates

of 0%–3.3%.⁵ Regarding the pathogenetic mechanisms, cerebral hemorrhage is caused by microaneurysms induced by infection and inflammation, unlike cerebral infarction which occurs via arteritis, thrombosis, vasospasm, or septic embolization.⁵ Although *Klebsiella* species are uncommon pathogens for adult bacterial meningitis, they occur frequently in patients with underlying conditions including DM, alcoholism, liver cirrhosis, or COM, and the overall mortality rate of *klebsiella* meningitis has been reported to be very high at 40%–100%.⁶

The present patient had several underlying diseases such as DM, liver cirrhosis, and COM that were strongly associated with bacterial meningitis, and her disease was confirmed as *Klebsiella pneumoniae* meningitis through blood and CSF cultures. Brain CT revealed spontaneous pneumocephalus and SAH as uncommon complications of bacterial meningitis occurring together. Even through pneumocephalus is known to be usually benign itself,⁴ since the causative pathogen for bacterial meningitis was *Klebsiella pneumoniae* and it was accompanied with SAH, the prognosis of the patient was thought to be poor even when appropriate treatment was applied. To the best of our knowledge, this is the first report of both spontaneous pneumocephalus and SAH accompanying adult bacterial meningitis, specifically *Klebsiella pneumoniae* meningitis.

Ethics Statement

This report was approved as being exempt from an IRB review (no. 2022-02-005).

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

ORCID iDs

Eun Ji Lee	https://orcid.org/0000-0001-6690-5783
Rae On Kim	https://orcid.org/0000-0002-7859-6209
Mina Lee	https://orcid.org/0000-0002-5971-3633
Byung-Euk Joo	https://orcid.org/0000-0003-3566-1194

Author Contributions

Conceptualization: Eun Ji Lee, Byung-Euk Joo. Data curation: all authors. Formal analysis: Eun Ji Lee, Byung-Euk Joo. Investigation: all authors. Methodology: Eun Ji Lee, Byung-Euk Joo. Supervision: Byung-Euk Joo. Visualization: Eun Ji Lee, Byung-Euk Joo. Writing—original draft: Eun Ji Lee. Writing—review & editing: Byung-Euk Joo.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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