She denied headache. Hematological investigation revealed mild leukocytosis with a total white blood cell (WBC) count of 10,500/μL and an elevated erythrocyte sedimentation rate (ESR) of 42 (normal 0-20 mm/hr). Urine analysis was negative for blood and protein, but urine culture was positive for *Escherichia coli* (E. coli). Under a diagnosis of urinary tract infection, she was treated with fluid and trimethoprim sulfamethoxazole (cebatrim® Jaytech Biogen, Switzerland), but despite aggressive fluid and antibiotic therapy, she failed to respond to treatment. Five days after admission, while still febrile, she developed a severe headache and acute confusion, and was transferred to the neurosurgical department. Neurological examination revealed disorientation with respect to time and place. At this time, her body temperature was 38.3°C, WBC count 15,200/μL, and ESR 63 mm/hr, but her coagulation profile, urea and electrolytes, liver and thyroid function, calcium, blood sugar, serum folate, and chest X-ray were unremarkable. Simple lateral radiography and computed tomography of the skull showed extensive intraventricular air in lateral ventricles (Fig. 1), which raised the possibility of bacterial meningitis with gas-forming organisms. Accordingly, a lumbar puncture was performed. The opening pressure was 200 mm H2O, and cerebrospinal fluid analysis showed bacterial meningitis which later revealed streptococcus pneumonia. The patient was treated with antibiotics and responded remarkably well. Repeat CT performed after 2 weeks of treatment showed complete resolution of the intracranial gas. Here, the authors report an unusual case of a pneumocephalus caused by meningitis in the absence of head trauma or a neurosurgical procedure.

**Key Words**: Pneumocephalus · Meningitis.

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**INTRODUCTION**

Pneumocephalus describes “the presence of air or gas within the cranial cavity”. It arises when a negative pressure gradient exists across a breach in the integrity of cranial bone or dura allows air to enter the cranial cavity. Pneumocephalus commonly results from craniofacial trauma, a neurosurgical procedure, or post-radiation necrosis<sup>1-3</sup>. However, in the absence of craniofacial trauma and a neurosurgical procedure, bacterial meningitis can be a rare cause of pneumocephalus. Here, we report an unusual case of pneumococcal meningitis causing spontaneous pneumocephalus. The pathophysiological mechanism of this uncommon entity is discussed with a review of relevant literature.

**CASE REPORT**

A 62-year-old woman was admitted to our urology department with the diagnosis of urinary tract infection. She complained of a febrile sensation and of night sweats for 2 weeks. At admission, she had mild fever of 37.1°C, but was alert with stable vital signs. There was no history of a trivial head injury and she denied headache. Hematological investigation revealed mild leukocytosis with a total white blood cell (WBC) count of 10,500/μL and an elevated erythrocyte sedimentation rate (ESR) of 42 (normal 0-20 mm/hr). Urine analysis was negative for blood and protein, but urine culture was positive for *Escherichia coli* (E. coli). Under a diagnosis of urinary tract infection, she was treated with fluid and trimethoprim sulfamethoxazole (cebatrim® Jaytech Biogen, Switzerland), but despite aggressive fluid and antibiotic therapy, she failed to respond to treatment. Five days after admission, while still febrile, she developed a severe headache and acute confusion, and was transferred to the neurosurgical department. Neurological examination revealed disorientation with respect to time and place. At this time, her body temperature was 38.3°C, WBC count 15,200/μL, and ESR 63 mm/hr, but her coagulation profile, urea and electrolytes, liver and thyroid function, calcium, blood sugar, serum folate, and chest X-ray were unremarkable. Simple lateral radiography and computed tomography of the skull showed extensive intraventricular air in lateral ventricles (Fig. 1), which raised the possibility of bacterial meningitis with gas-forming organisms. Accordingly, a lumbar puncture was performed. The opening pressure was 200 mm H2O, and cerebrospinal fluid analysis showed bacterial meningitis which later revealed streptococcus pneumonia. The patient was treated with antibiotics and responded remarkably well. Repeat CT performed after 2 weeks of treatment showed complete resolution of the intracranial gas. Here, the authors report an unusual case of a pneumocephalus caused by meningitis in the absence of head trauma or a neurosurgical procedure.

**Key Words**: Pneumocephalus · Meningitis.
Meningitis and rarely with mixed aerobic-anaerobic meningi-
cephalus, and is usually associated with Clostridium perfringens
organism, but CSF culture later revealed pneumo-
pressure was 180 mm H₂O and a cloudy fluid was obtained.
Cerebrospinal fluid (CSF) contained 1059 cells/mL (92% poly-
morphonuclear cells), protein 6.2 g/dL, and a glucose level of
10% of her serum glucose level. CSF gram staining showed no
organism, but CSF culture later revealed *streptococcus pneu-
nia*. She was treated with ceftriaxone (Hanmi Pharmaceuticals,
Korea) and vancomycin (CJ Pharmaceuticals, Korea) for 14
days, and this resulted in a remarkable improvement as evi-
denced by level of consciousness and orientation. Repeat CT
performed 14 days after initiating ceftriaxone and vancomycin
showed complete resolution of the pneumocephalus (Fig. 2).
Patient was subsequently discharged and followed regularly on
an OPD basis, but remained asymptomatic for 6 months.

**DISCUSSION**

Air within the cranial vault usually implies a communication
with the atmosphere or a paranasal sinus. Pneumocephalus has
been reported after central nervous system trauma, surgery, air
embolus, brain abscess, or postradiation necrosis of skull ap-
pendages. On the other hand, spontaneous pneumocephalus
caused by meningitis is an extremely rare cause of pneumo-
cephalus, and is usually associated with Clostridium perfringens
meningitis and rarely with mixed aerobic-anaerobic meningi-
tis. The first case of pneumocephalus associated with bacterial
meningitis in the absence of predisposing conditions was re-
ported in 1985 in an adult with a mixed aerobic-anaerobic in-
fec tion. Since then, only a few cases of pneumocephalus asso-
ciated with meningitis caused by various aerobic and anaerobic
organisms have been reported in adults. Intracranial infec-
tions can produce gas by putrefaction due to the autolysis of
intracellular proteins and glucose decomposition. Ischemia may
also feature because the gas produced might not be absorbed.
These factors may act singly or in combination and resulting in
pneumocephalus. Tanaka et al. reported three cases of pneu-
mocephalus suspected to have resulted from aerobic bactere-
mia caused by *Enterobacter cloacae* (*E. cloacae*), *E. coli*, and
*Klebsiella aerogenes* (*K. aerogenes*), respectively. In two of these
cases, *E. cloacae* and *K. aerogenes* were isolated from cerebro-
spinal fluid. Pneumocephalus itself is usually benign and intra-
cranial air is absorbed in 85% of patients during the first week.

Treatment of this condition depends on clinical status, the
extent and progression of the entrapped air, and the etiology.
Most cases resolve under conservative management and close
monitoring, although the rate at which the air is absorbed is
uncertain. Diagnosis can be made after performing a CT scan,
because CT is capable of detecting as little as 0.5 mL of air in the
intracranial compartment. However, pneumocephalus asso-
ciated with meningitis usually has a fatal outcome, especially in
neonates and infants. Our patient, who was diagnosed as uri-
inary tract infection initially, was treated with intravenous antibi-
otics based on a CSF report suggestive of meningitis, and re-
ponded remarkably to treatment. In fact, a repeat CT scan
performed two weeks after initiating intravenous antibiotics
showed no evidence of pneumocephalus. Early suspicion,
correct diagnosis, and appropriate antibiotic therapy with ade-
quate CSF analysis and radiological studies are essential in cases
of pneumocephalus associated with meningitis.

**CONCLUSION**

Although rare, meningitis should be considered as a possible
cause of pneumocephalus. Careful diagnostic trials including
CSF analysis are indispensable in patients that exhibit focal neu-
rologic deficits or neurologic deterioration.

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