

Case Report

Spontaneous Pneumocephalus Caused by Pneumococcal Meningitis

Hyun Sook Kim, M.D., Ph.D.,¹ Seok Won Kim, M.D., Ph.D.,² Sung Hoon Kim, M.D., Ph.D.³

Department of Internal Medicine,¹ Soonchunhyang University College of Medicine, Seoul, Korea

Department of Neurosurgery,² School of Medicine, Chosun University, Gwangju, Korea

Department of Rehabilitation,³ Wonju College of Medicine, Yonsei University, Wonju, Korea

Pneumocephalus is a condition characterized by the presence of air in the cranium, and it is mainly caused by trauma or a neurosurgical procedure. In the absence of head trauma or a neurosurgical procedure, meningitis is an extremely rare cause of pneumocephalus. Here, the authors present a rare case of spontaneous pneumocephalus caused by pneumococcal meningitis, in which simple lateral radiography and computed tomography (CT) findings of the skull suggested the diagnosis. Cerebrospinal fluid analysis showed bacterial meningitis which later revealed streptococcus pneumoniae. 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.

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^{1,2)}. 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/ μ L 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/ μ L, 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

• Received : November 13, 2012 • Revised : December 27, 2012 • Accepted : April 8, 2013

• Address for reprints : Seok Won Kim, M.D., Ph.D.

Department of Neurosurgery, School of Medicine, Chosun University, 365 Pilmun-daero, Dong-gu, Gwangju 501-717, Korea

Tel : +82-62-220-3126, Fax : +82-62-227-4575, E-mail : chosunns@chosun.ac.kr

• This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.



Fig. 1. Skull lateral radiograph and brain computed tomographic scan reveal multiple air densities in the cranial cavity.

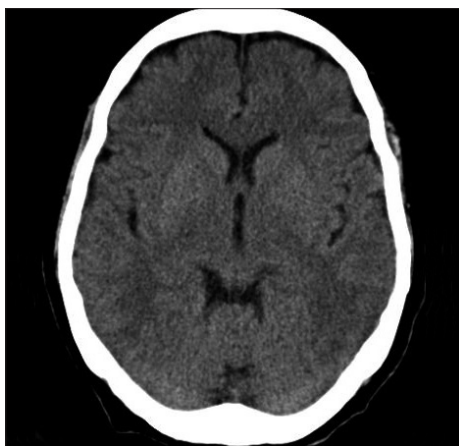


Fig. 2. Brain computed tomography scan performed 2 weeks after initiating appropriate antibiotic therapy shows complete resolution of the pneumocephalus.

pressure was 180 mm H₂O and a cloudy fluid was obtained. Cerebrospinal fluid (CSF) contained 1059 cells/mL (92% polymorphonuclear 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 pneumoniae*. She was treated with ceftriaxone (Hanmi Pharmaceuticals, Korea) and vancomycin (CJ Pharmaceuticals, Korea) for 14 days, and this resulted in a remarkable improvement as evidenced 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 appendages^{2,3,10}. On the other hand, spontaneous pneumocephalus caused by meningitis is an extremely rare cause of pneumocephalus, and is usually associated with *Clostridium perfringens* meningitis and rarely with mixed aerobic-anaerobic meningi-

tis⁸). The first case of pneumocephalus associated with bacterial meningitis in the absence of predisposing conditions was reported in 1985 in an adult with a mixed aerobic-anaerobic infection⁶. Since then, only a few cases of pneumocephalus associated with meningitis caused by various aerobic and anaerobic organisms have been reported in adults^{3,11}. Intracranial infections 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.¹¹ reported three cases of pneumocephalus suspected to have resulted from aerobic bacteremia 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 cerebrospinal fluid. Pneumocephalus itself is usually benign and intracranial air is absorbed in 85% of patients during the first week⁸. 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 uncertain¹. 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 compartment⁷. However, pneumocephalus associated with meningitis usually has a fatal outcome, especially in neonates and infants^{5,9}. Our patient, who was diagnosed as urinary tract infection initially, was treated with intravenous antibiotics based on a CSF report suggestive of meningitis, and responded remarkably to treatment. In fact, a repeat CT scan performed two weeks after initiating intravenous antibiotics showed no evidence of pneumocephalus^{4,5,9}. Early suspicion, correct diagnosis, and appropriate antibiotic therapy with adequate 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 neurologic deficits or neurologic deterioration.

References

- Ajalloveyan M, Doust B, Atlas MD, Fagan PA : Pneumocephalus after acoustic neuroma surgery. *Am J Otol* 19 : 824-827, 1998
- Goldmann RW : Pneumocephalus as a consequence of barotrauma. *JAMA* 255 : 3154-3156, 1986
- Haran RP, Chandy MJ : Symptomatic pneumocephalus after transsphenoidal surgery. *Surg Neurol* 48 : 575-578, 1997
- Heidemann SM, Meert KL, Perrin E, Sarnaik AP : Primary clostridial meningitis in infancy. *Pediatr Infect Dis J* 8 : 126-128, 1989
- Kassim Z, Aziz AA, Haque QM, Cheung HA : Isolation of *Proteus mirabilis* from severe neonatal sepsis and central nervous system infection with extensive pneumocephalus. *Eur J Pediatr* 162 : 644-645, 2003
- Maliwan N : "Spontaneous" pneumocephalus associated with mixed

- aerobic-anaerobic bacterial meningitis. *J Infect Dis* 152 : 847-848, 1985
7. Osborn AG, Daines JH, Wing SD, Anderson RE : Intracranial air on computerized tomography. *J Neurosurg* 48 : 355-359, 1978
 8. Penrose-Stevens A, Ibrahim A, Redfern RM : Localized pneumocephalus caused by *Clostridium perfringens* meningitis. *Br J Neurosurg* 13 : 85-86, 1999
 9. Pooboni SK, Mathur SK, Dux A, Hewertson J, Nichani S : Pneumocephalus in neonatal meningitis : diffuse, necrotizing meningo-encephalitis in *Citrobacter* meningitis presenting with pneumatosi oculi and pneumocephalus. *Pediatr Crit Care Med* 5 : 393-395, 2004
 10. Ruelle A, Severi P, Andrioli G : Intraventricular pneumocephalus after posterior fossa and CSF shunting surgery. Case report. *J Neurosurg Sci* 38 : 167-170, 1994
 11. Tanaka T, Takagi D, Takeyama N, Kitazawa Y : "Spontaneous" pneumocephalus associated with aerobic bacteremia. *Clin Imaging* 13 : 134-139, 1989