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Behind the Air Pocket: Pneumocephalus Exposing an Osteomeningeal Breach Complicated by Otogenic Meningitis

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Abstract **Case Report**

Pneumocephalus without trauma or surgery should raise suspicion for an underlying osteomeningeal breach and infectious origin. We report the case of an 80-year-old female presenting with fever and altered mental status whose brain CT showed extra-axial air in the frontal and right temporal regions. Bone window analysis revealed right otomastoiditis associated with a temporal osteomeningeal defect. Contrast-enhanced MRI demonstrated diffuse leptomeningeal enhancement consistent with meningitis. This case highlights spontaneous pneumocephalus as an early radiological sign of otogenic meningitis requiring urgent management.

Keywords: Pneumocephalus, Otomastoiditis, Meningitis, Skull base defect, Computed tomography, Elderly.

INTRODUCTION

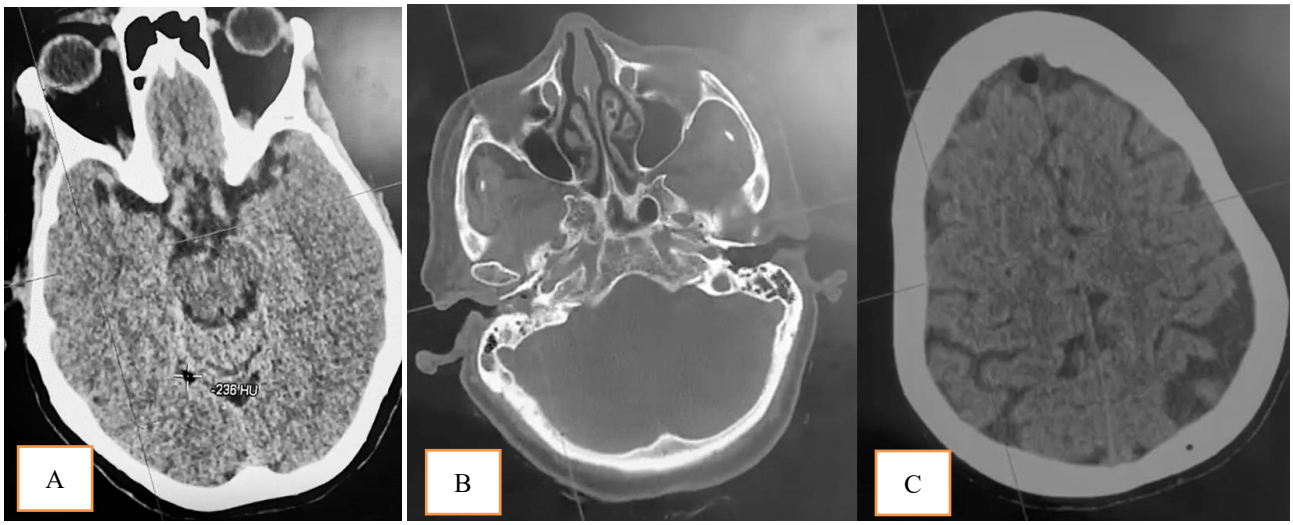
Pneumocephalus is defined as the presence of air within intracranial compartments and most commonly occurs after craniofacial trauma or neurosurgical procedures. In the absence of these conditions, spontaneous pneumocephalus should prompt careful investigation for skull base defects or infectious etiologies allowing communication between extracranial air-containing structures and intracranial spaces. Otogenic infections, particularly otomastoiditis, represent an uncommon but recognized cause of osteomeningeal breach and may lead to severe intracranial complications including meningitis. Early radiological identification of intracranial air collections and associated bone defects plays a crucial role in diagnosis and therapeutic management [1–3].

CASE PRESENTATION

An 80-year-old female patient presented to the emergency department with fever, headache, and altered mental status evolving over several days. There was no history of recent craniofacial trauma or neurosurgical intervention. Clinical examination revealed neck stiffness and confusion suggestive of meningeal irritation syndrome. Laboratory tests demonstrated elevated inflammatory markers with leukocytosis and increased C-reactive protein levels.

Emergency non-contrast brain computed tomography revealed multiple extra-axial intracranial air bubbles involving the bilateral frontal convexities and the right temporal region. Careful evaluation using bone window settings demonstrated opacification of the right mastoid air cells consistent with otomastoiditis associated with focal temporal bone osteomeningeal discontinuity suggesting a communication between mastoid air spaces and intracranial compartments. No traumatic fracture line was identified.

Complementary contrast-enhanced brain MRI demonstrated diffuse leptomeningeal enhancement predominantly involving the supratentorial compartments, consistent with meningitis. The imaging findings supported the diagnosis of pneumocephalus secondary to an otogenicosteomeningeal breach complicated by bacterial meningitis. The patient received intravenous broad-spectrum antibiotic herapy followed by surgical management of the temporal osteomeningeal defect.



Axial brain CT images [A, B] in parenchymal window demonstrate small pneumocephalus located in the frontal and right temporal regions
The axial bone window image [C] shows filling of the right otomastoid air cells consistent with otomastoiditis associated with a temporal osteomeningeal breach

Axial contrast-enhanced brain MRI demonstrates diffuse leptomeningeal enhancement along the cerebral convexities, consistent with infectious meningeal involvement in the setting of otogenic meningitis

DISCUSSION

Spontaneous pneumocephalus is an uncommon condition typically resulting from communication between intracranial compartments and adjacent aerated cavities such as paranasal sinuses or mastoid air cells through osseous and dural defects. Otogenic infections represent a rare but important cause because mastoid air cell erosion may create a direct pathway for intracranial air entry and bacterial dissemination leading to meningitis [2,4].

Two principal mechanisms explain intracranial air entry. The ball-valve mechanism allows unidirectional airflow through a dural defect, whereas the inverted soda-bottle mechanism results from cerebrospinal fluid leakage generating negative intracranial pressure that favors air aspiration into intracranial spaces [5]. In infectious contexts, pneumocephalus most frequently reflects communication with aerated cavities rather than gas production by microorganisms themselves [3].

Computed tomography remains the reference imaging modality for detecting even minimal intracranial air collections and identifying associated skull base defects. Bone window analysis is essential for detecting subtle temporal bone erosions related to otomastoiditis. Magnetic resonance imaging plays a complementary role by demonstrating leptomeningeal enhancement and evaluating infectious intracranial complications such as meningitis, cerebritis, or abscess formation [6–8].

Early recognition of spontaneous pneumocephalus in association with otomastoiditis is essential because delayed diagnosis may lead to severe neurological deterioration, intracranial sepsis, or tension pneumocephalus requiring urgent neurosurgical intervention [1,7].

CONCLUSION

Pneumocephalus involving the frontal and temporal regions in the absence of trauma should systematically prompt careful evaluation of the temporal bone and mastoid air cells to search for an

osteomeningeal breach. In the context of otomastoiditis, intracranial air collections may represent the first radiological sign of otogenic meningitis and require urgent multidisciplinary management combining antibiotic therapy and surgical repair to prevent life-threatening complications.

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