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CASE REPORT

Pneumocephalus resulting from traumatic pneumothorax and brachial plexus avulsion

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Abstract

Background: Traumatic pneumocephalus is commonly encountered after basal skull fractures and rarely associated with blunt chest trauma. Here, we report a case of pneumocephalus caused by traumatic pneumothorax and brachial plexus avulsion.

Case Presentation: A 20-year-old male was admitted to our hospital following a motorcycle accident with complete paralysis of the right upper limb. 2 days later, follow-up computed tomography revealed a slight right pneumothorax, pneumomediastinum around the neck, and intracranial air without skull fracture. Air migrates into the subarachnoid space through a dural tear caused by a brachial plexus avulsion. The pneumocephalus immediately improved after the insertion of a chest drain.

Conclusion: Pneumothorax combined with brachial plexus avulsion could lead to pneumocephalus. Immediate chest drainage might be the best way to stop the migration of air; however, care should be taken to not worsen cerebrospinal fluid leakage.

KEYWORDS

blunt chest trauma, brachial plexus avulsion, cerebrospinal fluid leakage, pneumocephalus, pneumothorax

INTRODUCTION

Pneumocephalus, defined as the presence of air in the cranial cavity, is commonly encountered after brain surgery or head trauma. Although rare, chest trauma can be associated with pneumocephalus in cases of penetrating trauma or thoracic vertebral injuries that cause a fistula between the spinal subarachnoid space and thoracic cavity.[1,2] The air around the spinal cord can migrate through the subarachnoid space into the cranial cavity. However, direct communication between the subarachnoid space and air cavity is necessary for the development of pneumocephalus.

Here, we report a case of pneumocephalus caused by traumatic pneumothorax and brachial plexus injury that appeared unrelated.

CASE REPORT

A 20-year-old male was admitted to a local hospital for the high energy injury due to single-motorcycle rollover crash under drunkenness. On admission, his consciousness and vital signs were normal (Glasgow Coma Scale: E4V5M6), and physical examination revealed both complete paralysis and sensory deficit in the right upper limb. The Horner syndrome as autonomic nervous system disorder was not clear. Initial brain computed tomography (CT) revealed no abnormalities, and chest CT revealed a right pneumothorax with a fracture of the first rib. The right lung collapsed by less than 25%, and there was neither mediastinum nor subcutaneous emphysema. Therefore, the patient was treated conservatively. During the course of initial treatment, the patient was not on bed rest and allowed to walk around.

And there were neither episodes of increased intrathoracic pressure nor symptoms of infectious meningitis. 2 days after the accident, follow-up CT revealed pneumocephalus with a slight progression of pneumothorax, pneumomediastinum, and subcutaneous emphysema. Air was also detected in the right C7/Th1 intervertebral foramen and subdural space of the spinal canal (Figure 1A–D) An 8 Fr. chest tube was inserted and placed under the water sealing management, and the prophylactic antibiotics was not administered to the patient to prevent meningitis. The pneumothorax improved immediately. The day after initiating chest drainage, brain CT revealed a rapid reduction in intracranial air (Figure 2A). Although the patient had no symptoms of cerebrospinal fluid (CSF) leakage, such as headache or loss of consciousness, spinal magnetic resonance imaging (MRI) revealed hyperintense lesions around the right C7/Th1 intervertebral foramen on T2-weighted images, suggesting CSF leakage and nerve root avulsion (Figure 2B,C). On the fourth day, the chest tube was removed after a 24-hour clamp test which showed no air leak during the test. The patient was discharged without any recurrence of air migration on Day 16 after admission, although there was not any improvement in the right-arm paralysis. 2 months after the accident, CT myelography was performed as a preoperative examination of the nerve transfer for brachial plexus avulsion, and pseudomeningoceles were revealed in the right C5/C6, C6/C7, and C7/Th1 intervertebral foramen. Thus, above mentioned findings obtained by clinical imaging and neurological examination along clinical transit have implicated the existence of brachial plexus avulsion.

DISCUSSION

Traumatic pneumocephalus is predominantly associated with head injuries. Basal skull fractures involving the paranasal sinuses or petrous temporal bones can cause CSF leakage, which occasionally presents as rhinorrhea or otorrhea. Pneumocephalus is thought to be a risk factor for meningitis and could progress to tension pneumocephalus in rare cases.[3,4] Although most patients with pneumocephalus can be treated conservatively, they should be carefully monitored for consciousness and infection.

In the present case, no skull fractures were observed. The mechanisms underlying pneumocephalus are complex. Intrathoracic air migrated to the subcutaneous space

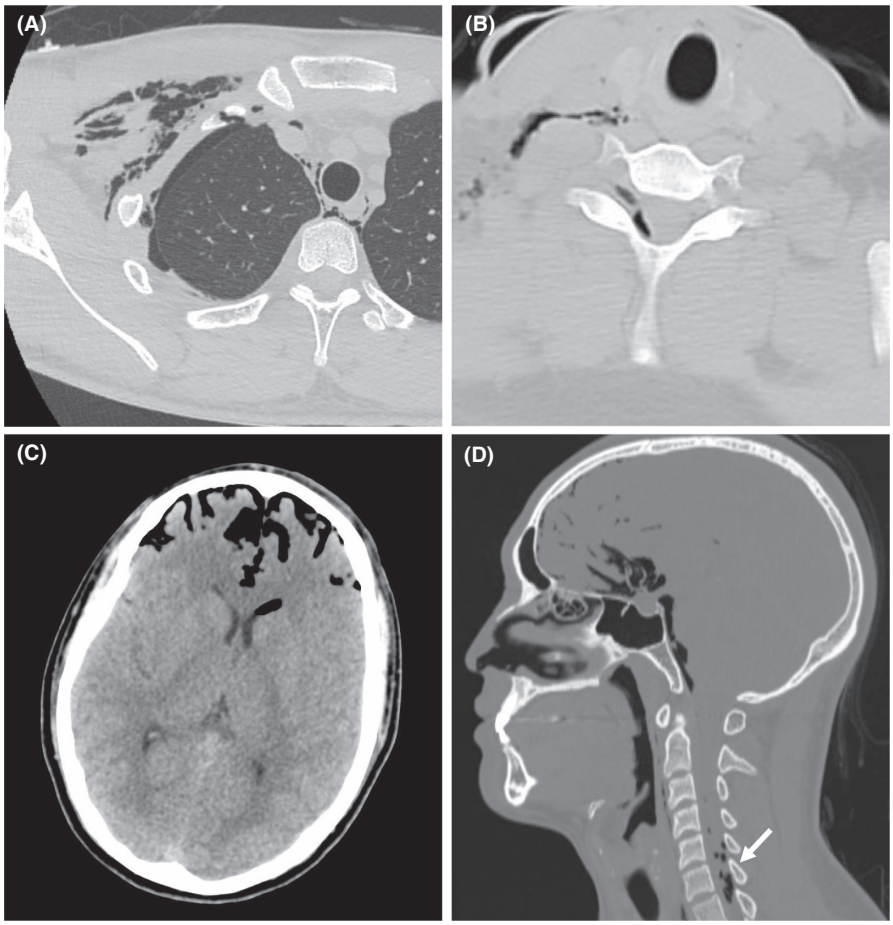

FIGURE 1 Follow-up computed tomography performed 2 days after the accident. (A) Slight pneumothorax, subcutaneous emphysema, pneumomediastinum, and first rib fracture of the right chest. (B) Spinal computed tomography image demonstrating air in the right C7/Th1 intervertebral foramen and subdural space of the spinal canal. (C) Intracranial air accumulating in the frontal or subarachnoid space and ventricles. (D) Sagittal images showing subarachnoid air around the spinal cord (arrow) and pneumocephalus.

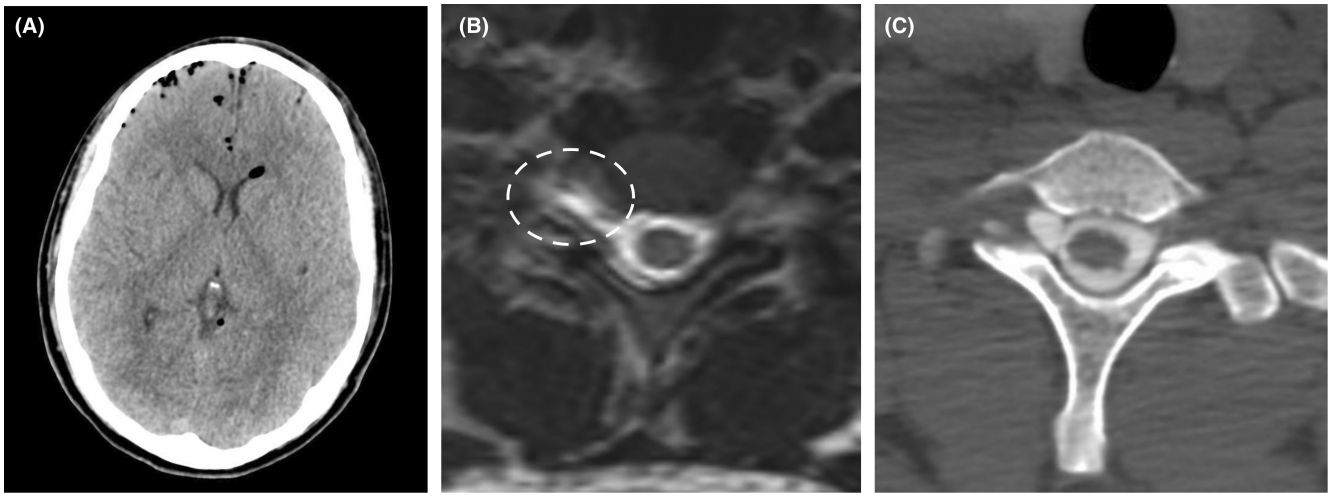

FIGURE 2 (A) Brain computed tomography revealing rapid absorption of intracranial air the day following initiation of chest drainage. (B) Spinal magnetic resonance imaging showing hyperintense lesions (dotted circle) around the right C7/Th1 intervertebral foramen on T2-weighted images. (C) Computed tomography myelography revealing a pseudomeningocele in the same region.

through a tear in the parietal pleura at the first rib fracture site. Air spreads through the soft tissues around the neck and enters the subarachnoid space through a dural tear caused by a brachial plexus avulsion. It is extremely rare for blunt chest trauma to develop into pneumocephalus without direct communication between the subarachnoid space and the thoracic cavity. There are only three previous reports of pneumocephalus with the same mechanism.[5–7] All these patients had more severe thoracic injuries that required mechanical ventilation or contained a tracheal laceration or multiple rib fractures; one patient even had a tension pneumocephalus requiring burr-hole opening and subdural drainage. Our patient developed pneumocephalus despite relatively mild thoracic injuries because of his good general condition and ambulation. The upright head position worsened CSF leakage and made it easy for air to accumulate in the intracranial space. Generally, the pleural drainage is performed for a tension or large pneumothorax which occupies more than 25% of the hemithorax. But, our case suggests that the continuous air supply from the pleural cavity combined with a dural tear could lead to exacerbation of pneumocephalus, even if it were slight.

Brachial plexus avulsion is the most severe type of brachial plexus injury. The nerve roots of the brachial plexus are stretched and detached from the spinal cord by severe traction from the upper limb, causing motor and sensory deficits. Pseudomeningocele resulting from CSF leakage through a dural tear is an important sign of brachial plexus avulsion. CT myelography and MRI are reliable imaging modalities for diagnosing and assessing the severity of nerve root injuries.[8] Although CSF leakage from the intervertebral foramen usually improves spontaneously, it sometimes accumulates in the soft tissues around the neck and can leak into the thoracic cavity through the pleural fistula in severe cases.[9] Intracranial hypotension should be considered if patients with brachial plexus avulsion complain of headaches or an altered mental status.

We successfully treated our patient with chest drainage; however, the low intrathoracic pressure might have exacerbated the CSF leakage. Bilsky et al.[10] reported three cases of tension pneumocephalus resulting from iatrogenic CSF leakage after thoracic surgery. Two patients showed improvement after discontinuing chest tube suction. In the present case, the chest tube drained only a small amount of air; CSF leakage into the thoracic cavity was not observed. If the chest tube drains the clear fluid, the suction pressure should be minimized to decrease CSF leakage.

CONCLUSION

Traumatic pneumothorax combined with brachial plexus avulsion could lead to pneumocephalus even in cases of mild chest trauma. Chest drainage might become crucial to prevent air entry into the subarachnoid space.

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CONFLICT OF INTEREST STATEMENT
The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT
Approval of the research protocol: N/A.
Informed consent: Informed consent was obtained from the patient.

Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.

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