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# An Unusual Case of Thoracic Tumor Resection Complicated by Pneumocephalus

**AUTHORS:**
Scott L[a,b]; Shnawa A[b]; Helenius J[b]; Small JE[c]; Voetsch B[b]; Quadri SM[d]

**CORRESPONDING AUTHOR:**
Aya Shnawa, MD
Department of Neurology
Tufts Medical Center
260 Tremont Street
12th Floor
Boston, MA 02116
Email: aya.shnawa@gmail.com

**AUTHOR AFFILIATIONS:**
a. Department of Neurology
Tufts Medical Center
Boston, MA 02116

b. Department of Neurology
Beth Israel Lahey Health
Burlington, MA 01805

c. Department of Radiology
Beth Israel Lahey Health
Burlington, MA 01805

d. Department of Thoracic Surgery
Maine Medical Center
Portland, ME 04102

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| **Background** | Pneumocephalus, the presence of air intracranial or extra-axial, is most frequently associated with traumatic brain injury. Neurotrauma accounts for roughly 75% of pneumocephalus cases. In contrast, thoracic surgery presents an exceedingly rare cause of this complication. |
| **Summary** | We describe the case of a 62-year-old woman with a left upper lobe lung mass who underwent thoracotomy for pneumonectomy with en-bloc chest wall resection of ribs 1-4. On postoperative day (POD) 10, she exhibited a concerning decline in mental status, presenting with severe headaches. Non-contrast head CT revealed intraventricular and subarachnoid pneumocephalus with mild-to-moderate hydrocephalus. Chest CT demonstrated a left-sided air-fluid filled post-pneumonectomy cavity and two punctate air collections within the left T2/T3 foramina and spinal canal, consistent with a subarachnoid-pleural fistula. To address the pneumocephalus and hydrocephalus, an external ventricular device (EVD) was placed for decompression. The patient subsequently recovered and was discharged following successful treatment. |
| **Conclusion** | This is a rare case of pneumocephalus emerging subsequent to thoracic surgery caused by a subarachnoid-pleural fistula. This complication underscores the importance of a multidisciplinary approach for both diagnosis and management. |
| **Key Words** | pneumocephalus; thoracic surgery; pneumoventriculomegaly; subarachnoid fistula; hydroaerique |

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## Case Description

Pneumocephalus, the presence of air in the cranial cavity, can manifest within or outside the brain itself. Common locations include ventricles, brain tissue, and surrounding spaces like epidural, subdural, and subarachnoid spaces.[1,2] Trauma is the leading cause, responsible for roughly 75% of cases, typically due to neurotrauma.[1,2] Less frequent etiologies involve congenital defects, gas-producing infections, and spontaneous or iatrogenic injuries.[2] Iatrogenic causes encompass all surgical procedures, with neurosurgical interventions, particularly craniotomies, being the most frequent implicated.[1-3] Pneumocephalus is very rarely encountered as a complication of thoracic surgery.[4]

A 62-year-old woman with a history of left upper lobe squamous cell lung carcinoma underwent elective thoracotomy with pneumonectomy and en bloc chest wall resection of ribs 1-4 five weeks after neoadjuvant chemotherapy. To achieve complete tumor removal (R0 resection), disarticulation of ribs 2 and 3 from the corresponding vertebral body spinous processes was necessary. Notably, the tumor did not involve adjacent structures (transverse processes or vertebral bodies), eliminating the need for intraoperative neurosurgical or spinal involvement. The resulting chest wall defect was covered entirely by the scapula, obviating the need for reconstruction with artificial materials.

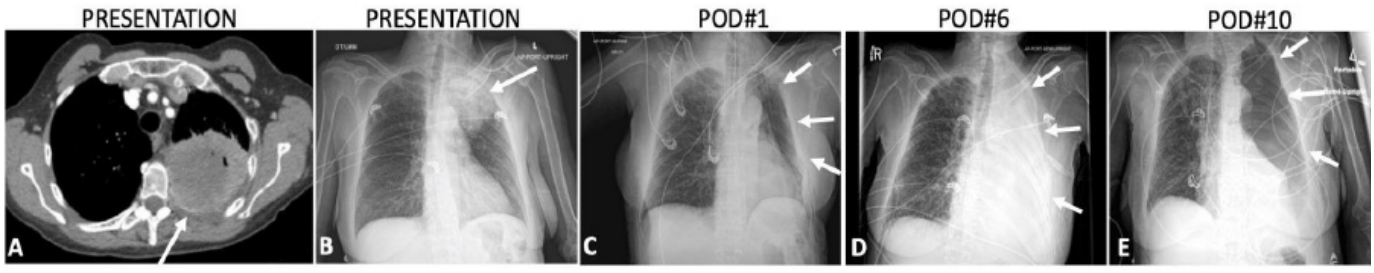
Following pneumonectomy, a 28Fr chest tube was placed in the left hemithorax and removed successfully on POD 1. As expected postoperatively, a left-sided pleural effusion developed. On POD 9, the chest tube insertion site spontaneously dehisced, resulting in chest fluid drainage and air ingress into the left pleural space. Pleural fluid analysis demonstrated no evidence of infectious etiology. To prevent ongoing contamination of the left pleural cavity, the chest drain site was surgically sutured closed (Figure 1).

On POD 10, the neurology team was emergently consulted due to progressive mental status decline and headaches. Examination revealed a Glasgow Coma Scale (GCS) score of 9, global aphasia, conjugate gaze, and absent blink reflex to threat. Corneal reflex was intact. Upper extremity pain localization was present, but lower extremity response was limited to withdrawal. Non-contrast head CT scan demonstrated intraventricular and subarachnoid pneumocephalus with mild-to-moderate hydrocephalus (Figure 2).

Given the initial suspicion of a subarachnoid-pleural fistula as the cause of pneumocephalus, a chest CT was obtained on the same day. The CT revealed an air- and fluid-filled cavity from a left thoracic pneumonectomy, along with two small areas of air density located within the left T2/T3 foramina and the left side of the spinal canal. These findings were supportive of a subarachnoid-pleural fistula; however, additional investigations were warranted for confirmation.

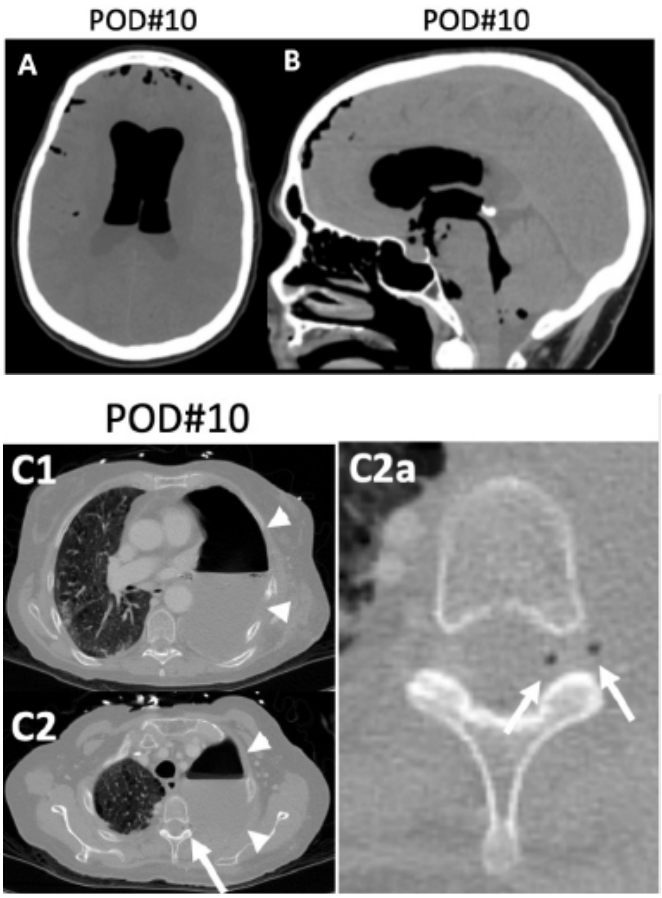
Neurosurgery emergently placed an external ventricular device (EVD) for pneumoventriculomegaly. Post-EVD placement, the patient demonstrated a Glasgow Coma Scale (GCS) score of 14 (E4, V4, M6). They remained alert, oriented, and followed commands without aphasia. Notably, only mild left ptosis was present, with intact extraocular movements and preserved strength in all extremities. To address postural headaches, an epidural blood patch was performed. Subsequently, the EVD was successfully removed, and the patient recovered prior to discharge.

**Figure 1.** Serial Chest Imaging Demonstrating Post-pneumonectomy Complications. Published with Permission




*A) Axial chest CT and B) AP chest X-ray at presentation show a necrotic left upper lobe mass (arrows). C) Postoperative day (POD) 1 chest X-ray demonstrates left hemithorax volume loss and air-filled pneumonectomy cavity (arrows). D) POD 6 chest X-ray reveals fluid opacification within the pneumonectomy cavity (arrows). E) POD 10 chest X-ray shows loss of pleural fluid level with new intraluminal air throughout the left pneumonectomy cavity (arrows).*

**Figure 2.** Pneumocephalus Secondary to Subarachnoid-pleural Fistula on POD 10. Published with Permission




*A, B: Axial and sagittal head CT scans demonstrate extensive intraventricular and subarachnoid air (pneumocephalus). C1, C2: Axial chest CT scans on the same day reveal an air- and fluid-filled left thoracic cavity post-pneumonectomy (arrowheads). C2 (white arrow): Punctate air foci within the left T2/T3 foramina and the spinal canal indicate a subarachnoid-pleural fistula. This is magnified in the inset (C2a, white arrows).*

## Discussion

Pneumocephalus is a very rare complication of thoracic surgery,[4] with mechanisms including the development of subarachnoid-pleural or subarachnoid-bronchopleural fistulas, and air escape into damaged nerve roots during persistent air leaks.[4,5] The epineurium (also known as the dural sleeve) extends into the intercostal nerves of the thorax. During thoracic surgery, actions like rib traction, damage, or removal, along with manipulation of the chest wall or vertebral bodies, can lead to injury of these dural extensions. Subsequently, in patients with existing dural injuries and persistent air leaks (e.g., pneumothorax), pneumocephalus may develop.[1,2]

Diagnostic workup for pneumocephalus hinges on the suspected etiology. For subarachnoid pleural fistula, pleural fluid analysis for CNS-specific ferritin aids diagnosis.[7] Myelography may be inconclusive, necessitating postmyelography CT for fistula localization.[1,7]

Pneumocephalus can manifest with a spectrum of neurological signs and symptoms. Headache, bruit hydroaerique (cranial splashing sounds with head movement), aphasias, hemiplegia, and decreased consciousness are common presentations; nausea and vomiting are frequently reported as well.[3,7] Significant dural shift can lead to cranial nerve palsies.[3,7]

Pneumocephalus, in this case, was attributed to a dural tear during chest wall resection for pneumonectomy. This likely created a CSF fistula connecting the thoracic cavity to the subarachnoid space and subsequently the intracranial compartment. Initially, the fistula was asymptomatic as the chest filled rapidly with pleural fluid. The effusion in the chest cavity likely tamponaded the dural tear, preventing air leak. However, on POD 9, spontaneous drainage via the chest tube potentially de-tamponaded the injury site. Exposed to air in the pleural space, the fistula allowed air to enter the thecal/dural sac during respiration due to increased intrathoracic pressure. While placement of a chest drain at this stage might have reduced pneumocephalus, it also carried the risk of mediastinal shift and cardiovascular compromise.

We attributed the patient's pneumocephalus to a dural tear during chest wall resection for pneumonectomy. This likely created a subarachnoid-pleural fistula, subsequently connecting to the intracranial space. Initial rapid pleural effusion masked the fistula's presence. Conservative management of subarachnoid-pleural fistulas typically includes 100% oxygen and strict bed rest. Refractory cases may require neurosurgical intervention (EVD or craniotomy) for cranial decompression and surgical fistula closure.[3,5,7] In our case, EVD placement significantly improved the patient's symptoms and normalized intracranial pressure. A subsequent blood patch potentially facilitated fistula closure, although its efficacy lacks robust evidence.[7] Based on this experience, we have modified our practice to suture the chest drain site upon pneumonectomy drain removal.

## Conclusion

Pneumocephalus is a rare but recognized complication of thoracic surgery, necessitating a prompt multidisciplinary approach for diagnosis and management of potential sequelae. This case underscores the critical role of early recognition and intervention to avert potentially devastating consequences.

## Lessons Learned

This case highlights the potential for subarachnoid-pleural or subarachnoid-bronchopleural fistula formation as a mechanism for pneumocephalus following thoracic surgery, particularly pneumonectomy. Based on this experience, we advocate for the routine practice of suturing the chest drain site upon removal following pneumonectomy to potentially minimize the risk of pneumocephalus development.

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