Delayed onset of intracerebral tension pneumocephalus 2 years after an anterior skull base fracture: Case report

Sokchan Sim¹, Yoshifumi Okada²

¹Country Director, Jeremiah’s Hope Center, Phnom Penh, Cambodia
²Department of Neurosurgery, Kitahara International Hospital, Tokyo, Japan

ABSTRACT

Pneumocephalus, the presence of air within the cranial cavity, is most commonly caused by trauma, tumor, infection and fistulation into the intracranial cavity or secondary to neurosurgery. We describe an unusually delayed neurological deficit from intracerebral tension pneumocephalus, 2 years following a head trauma with anterior skull base fracture. A 22-year-old man presented to our neurosurgical consultation with recurrent seizures and progressive right hemiparesis. The brain CT scan without iv contrast revealed an intracerebral tension pneumocephalus in the left frontal lobe, and a persistent hole in the left anterior frontal skull base connecting to pneumocephalus. We performed a left frontal craniotomy, and dura-plasty using galea flap to cover the skull-base bone defect. The patient has recovered gradually from his motor deficit after this surgery, finally to the level that he could play his favorite guitar. This is a rare case of a delayed development neurological deficit due to pneumocephalus from a “ball-valve” effect secondary to an old anterior skull base fracture.

Key words: Pneumocephalus, hemiparesis, craniotomy, dura-plasty

INTRODUCTION

Pneumocephalus is an air entrapment in the cranial cavity. It is commonly seen after head and facial trauma, ear infections, and tumors of the skull base or neurosurgical interventions. In some extremely rare cases, it happens spontaneously. Pneumocephalus is a complication of head injury in 3.9–9.7% of the cases. The accumulation of intracranial air can be acute (<72 h) or delayed (≥72 h). In tension pneumocephalus, the continuous accumulation of intracranial air is thought to be caused by a “ball-valve” mechanism. In turn, this may lead to a mass effect on the brain, with subsequent neurological deterioration and signs of herniation. Delayed tension pneumocephalus is extremely rare and requires proper neurosurgical attention. Surgical treatment involves aspiration of air into a syringe and closure of the dura defect through a cranial surgery.

CASE REPORT

A 22-year-old male presented to our neurosurgical consultation with chronic headaches, progressive right-sided weakness and occasional seizures. Two years prior to this visit, he suffered a severe traumatic brain injury by motorcycle accident. He had lost his consciousness for three days, and hospitalized in a provincial hospital for two weeks without any surgical intervention. He was then discharged home with persistent rhinorrhea for 10 months before it ceased spontaneously. 18 months after his injury, this patient began having progressive weakness on his right side of the body, and some episodes of seizures. He also reported occasional headaches. He was otherwise healthy before this accident. On examination, the young man had full...
consciousness, was alert and oriented. He had grade 3 out of 5 hemiparesis on his right side. A brain CT scan without iv contrast was obtained revealing a large pneumocephalus in the left frontal lobe. We noted a continuity of the air and the anterior skull base defect. (Figure.1)

CSF examination and culture were negative for infection, as well as the nasal swab. We decided to perform the surgery by doing bi-coronal approach for a left frontal craniotomy and repair of the dura defect on the frontal skull base using the pedunculated galea flap. (Figure.2)

The surgery went well without any complication. The post-operative course was without any significant event. No sign of infection was noticed. The patient recovered gradually from his motor deficit on his right side. The post-operative CT scan showed complete resorption of the intracerebral pneumocephalus. (Figure.3). Intravenous prophylactic antibiotics were used to prevent meningitis.

At one-month follow-up, his motor function on the right

---

**Figure 1:** A. Axial view of the CT scan showing hypodensity area in the left frontal lobe, pneumocephalus. B. Sagittal view presenting the large air space with its connection to the frontal skull base. C. Coronal view showing the bony defect of the anterior skull base.

**Figure 2:** A. Bi-coronal incision with preservation of large frontal galea. B. Galea still attached to the frontal base is lifted up.

**Figure 3:** Post-operative CT scan showing no hypodensity area in the left frontal lobe, complete disappearance of the pneumocephalus. A. Axial view B. Sagittal view C. Coronal view. Noted the small bone defect from craniotomy site.
body became normal that he could play his favorite guitar again. At three-month follow up, he had an episode of new seizures, we controlled his seizures with anti-epileptic drugs for two years afterward.

DISCUSSION

The term “pneumocephalus” was first coined more than one century ago by Luckett and Wolff independently. The term “tension pneumocephalus” was proposed by Ectors, Kessler, and Stern in 1962. Pneumocephalus or also known as pneumatocele or intracranial aerocele is defined as the presence of air in the epidural, subdural, or subarachnoid space, within the brain parenchyma or ventricular cavities. It is a complication of head injury in 3.9 – 9.7% cases. It also appears after supratentorial craniotomy surgery. The accumulation of intracranial air can be acute, less than 72 hours, or delayed, more than 72 hours.

Two mechanisms have been proposed to explain pneumocephalus. In the first mechanism, the pathophysiologic process starts with Cerebro-Spinal Fluid (CSF) leak in the presence of associated discontinuity of the cranial and leptomeningeal disruption. Subsequent development of relative negative Intra-cranial Pressure (ICP) results in a sufficient “vacuum effect” to cause additional accumulation of air within the cranial cavity. This air is generally distributed in the subarachnoid space. The second mechanism is based on the presence of a “one-way valve” at the site of the leptomeningeal tear. In this case, we found on the CT scan images a bone and dura defect in the left anterior skull base, in connection with intracerebral air collection. The air went in, and was trapped inside the frontal cerebral parenchyma. Slowly it became larger and more significant, putting mass effect into the brain tissue of the patient’s frontal lobe. The patient had experienced rhinorrhea (CSF leak through the nose) after the head trauma but disappeared spontaneously after 10 months. He then developed right hemiparesis and experienced episodes of seizures. Recurrent headaches were also a main complaint. These signs and symptoms were described in previous reports about tension pneumocephalus.

The diagnostic imaging for pneumocephalus is CT scan. “Mount Fuji sign” is described when there are bilateral hypodensituation collections, causing compression and separation of the frontal lobes on CT scan. In our case, an intraparenchymal air-filled long cavity was seen in the left frontal lobe, with its tip connecting to the frontal skull base.

Most cases of pneumocephalus tend to resolve spontaneously with conservative management. Nonoperative management involves oxygen therapy, maintaining the patient supine or in Trendelenburg position, prophylactic antimicrobial therapy (especially in posttraumatic cases), adequate analgesia, frequent neurologic checks, and repeated CT scans. The use of continuous high concentration inspired oxygen as a treatment modality for traumatic pneumocephalus may have certain theoretical benefits. Prompt decompression of intracranial air is the initial treatment of symptomatic pneumocephalus. The principles of subsequent treatment parallel those for a CSF leak. It is important to identify the site where the communication between the air cavity and the external environment occurs. If the site can be identified, the passage should be sealed off, thereby decreasing the possibility of worsening or recurrent pneumocephalus. Effective therapy of tension pneumocephalus through a controlled decompression using a closed water-seal drainage system has also been described. In our case, we performed a full scale left frontal craniotomy to evacuate air from the intraparenchymal cavity, closure of the skull base defect by using pedunculated galea flap, re-enforced by bio-glue as a sealing material.

CONCLUSION

Tension pneumocephalus is a life-threatening neurosurgical case. Although the development of this massive intracerebral air trap was delayed in this case, it caused significant neurological deficit. The patients who suffer from head trauma, with CSF leak should be subject for long term follow up. Disclosure: Nothing to disclose, and there was no conflict of interest among the authors. Research ethics: Informed consent has been obtained from the patient.

References