TENSION PNEUMOCRANIUM: THE LARGEST CASE SERIES

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ABSTRACT

We describe series of cases of symptomatic tension pneumocranium, a rare, potentially life-threatening complication of intracranial surgery. The Mount Fuji sign is a characteristic finding that can be observed on computed tomographic (CT) scans of the brain, in which bilateral subdural hypoattenuating collections cause compression and separation of the frontal lobes. The collapsed frontal lobes and the widening of the interhemispheric space between the tips of the frontal lobes have the appearance of the silhouette of Mount Fuji-hence, the Mount Fuji sign.

In cases of suspected pneumocranium, CT can play a vital role in determining the precise and definite location of the gas collection and the amount of mass effect on the brain which may need urgent recognition and intensive observation with decompression to minimize pressure over the brain parenchyma.

To our best knowledge this is the largest case series being reported to date.

Key words: Head injuries, craniocerebral trauma, pneumocephalus, intracranial pressure.

Introduction

Tension pneumocephalus is a neurosurgical emergency, characterized by intracranial subdural air causing mass effect on the brain. The compression and separation of frontal lobe with widened interhemispheric fissure and separated frontal lobar tips appearing as symmetrical cone shaped peak of Mount Fuji is a critically important sign. Ishiwata et al found this sign useful in diagnosing tension pneumocephalus, as it was not seen in any patient with non-tension pneumocephalus.[1]

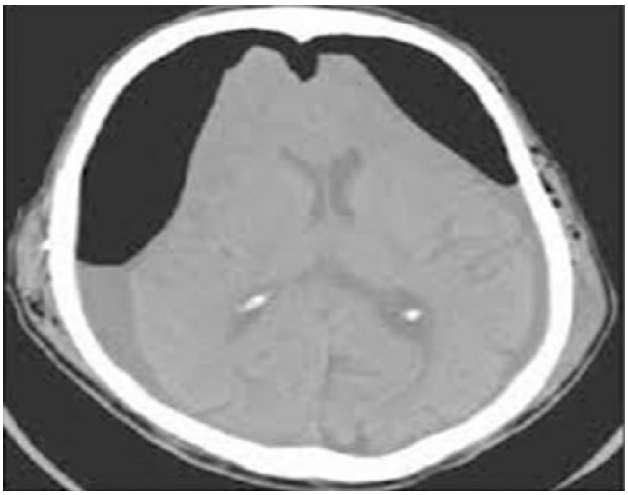

Figure 1: A "peaking sign" of bilateral compression of the frontal lobes by subdural air collections without the characteristic separation of the frontal lobes has also been linked to tension pneumocephalus

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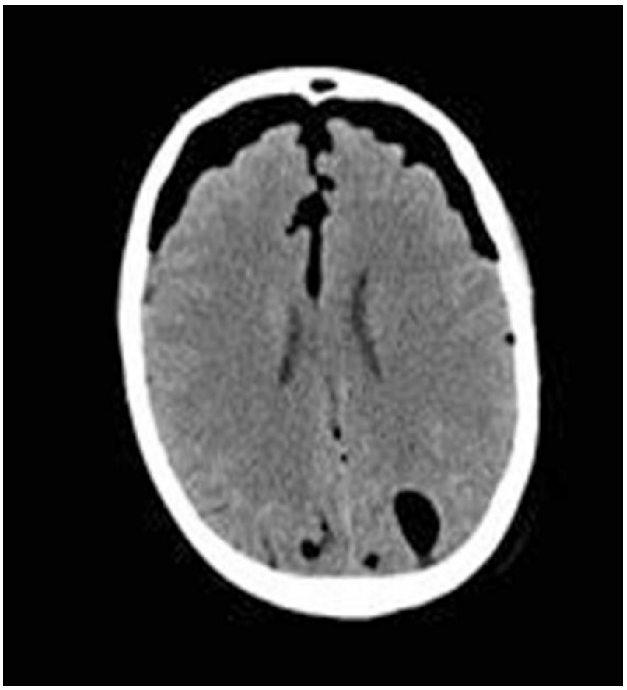
Tension pneumocephalus requires conditions that lead to increased air pressure within the subdural space. The increased pressure of air is assumed to be due to a ball-valve mechanism. This implies that air enters into the subdural space by means of a dehiscence in the skull base or calvaria and that the egress of air is blocked by an obstruction. An additional mechanism (i.e., posterior fossa surgery in the sitting position) has been postulated, but it was later discredited. In these cases, it was believed that nitrous oxide, which was used as an anesthetic, diffused into air-filled spaces and expanded the gaseous volume. Irrespective of the mechanism, the increased pressure may lead to extra axial mass effect with subsequent compression of the frontal lobes. The presence of air between the frontal tips suggests that the pressure of the air is at least greater than that of the surface tension of cerebrospinal fluid between the frontal lobes.[2]

Symptomatic pneumocranium manifested as impaired mental status, headaches, and grand mal seizures, early in the postoperative course after transsphenoidal pituitary surgery. After transsphenoidal surgery, the intracranial contents are in direct continuity with the nasopharynx, providing a potential route for such a one-way valve. Furthermore, a Cushing response, including systemic hypertension and bradycardia (secondary to intracranial hypertension) was seen, which has not been previously described in association with symptomatic pneumocranium. Other factors predisposing to tension pneumocranium in our patients included: cerebrospinal fluid leaks, postoperative positive-pressure mask ventilation, large pituitary tumors, and intraoperative lumbar drainage catheters.[3]

The prevalence of tension pneumocephalus following the evacuation of chronic subdural hematomas has been reported from 2.5% to 16%.[4]

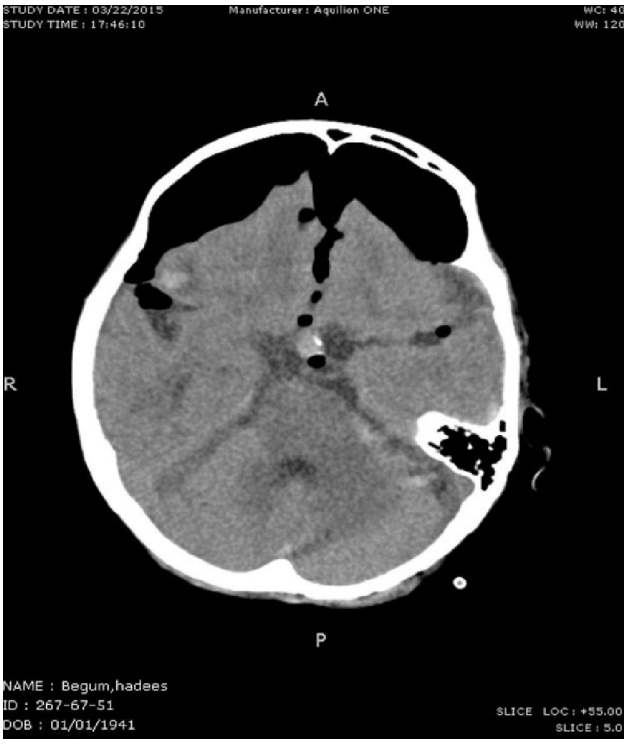
Surgical drainage of the pneumocranium and repair of any coexistent cerebrospinal fluid leak markedly improved neurologic status. Symptomatic pneumocranium occurring early in the postoperative course after transsphenoidal pituitary surgery is rare, but prompt recognition and treatment of this condition can be life-saving.[3]



Axial unenhanced computed tomogram revealing the huge bifrontal pneumocephalus

Case 1

74 yrs. old female, with no known co-morbid, presented with loss of vision in temporal lobes. She was electively admitted for transphenoidal excision of pituitary adenoma. Post operatively she went into diabetes insipidus and was conservatively managed by endocrinologist. She responded to treatment but had low GCS, which included spontaneous eye opening and localizing pain. On the 20th day, GCS dropped, CT scan showed massive tension pneumocranium with a classical MOUNT FUJI SIGN, where the air pressure was greater than the surface tension of CSF between the frontal lobes, resulting in widening of interhemispheric space between frontal lobes. Bilateral burr holes were placed in OR. On 22nd day, she went into afibrillation for which cardio version was done. GCS was constantly dropping and she now developed abnormal flexion and started subclinical seizures. By 25th day, her neurological condition further detoriated, having perfused nasal bleed, tachypnea, tachycardia, GCS 3/15 with fixed dilated pupils. ECG showed sinus tachycardia and she expired.



Subdural air causing mass effect on the brain

CT scan shows pnumocephalous along with high density in right frontoparietal region representing hemorrhage in the surgical bed.

Case 2

32 yrs old male patient, presented with headache, frequent episodes of fits and left sided weakness gradually since 2009, on examination he was drowsy, disoriented to time place and person with power in bilateral lower limbs 0/5. Following investigations patient was diagnosed as grade 3 oligodendroglioma. Patient was then planed for craniotomy debulking of SOL and neuronavigation. Post procedure CT scan showed right frontoparital craniotomy defect and pnumocephalous along with high density in right frontoparietal region representing hemorrhage in the surgical bed. Post operatively patient was shifted to special care for close monitoring, where he improved GCS and was stable. Patient has presented twice in emergency department following his surgery with complains of fever and episodes of partial seizure of right arm and leg. He was managed with anti-epileptics and anti-pyretic. Status of pneumocranium could not be followed since patient has not undergone radiographic imaging since then.

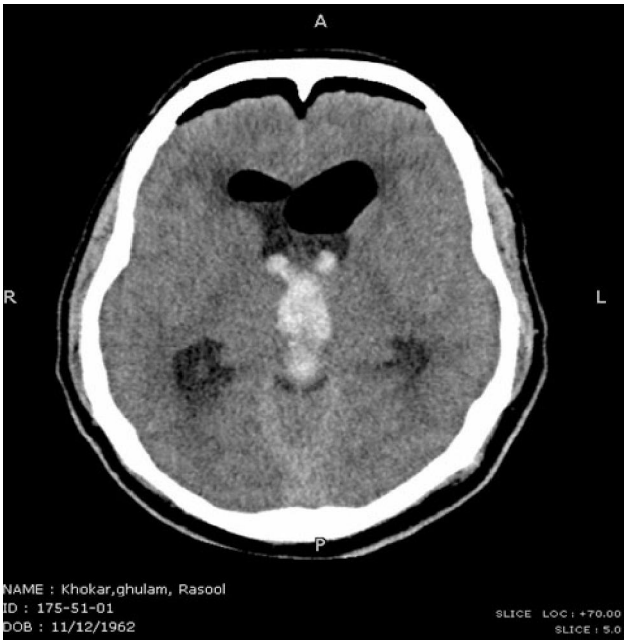
Case 3

53 yrs old male patient came with complains of headache, difficulty in walking, dizziness and vomiting. MRI was done which showed a large lesion in tectal plate and 4th ventricle associated with internal hemorrhage causing moderate obstructive hydrocephalous. Patient was diagnosed as tectal plate glioma. He underwent surgery and his ventri-culoplasty and EVD was done. After surgery he went on ventilator support. He was weaned off and his EVD was removed. After few days GCS started dropping therefore CT scan was repeated which showed air compressing the frontal horns with mild separation of interhemispheric fissure, with acute onset of hemorrhage in the 3rd, 4th and lateral ventricles, hydrocephalus and cerebral edema. Hence, EVD was placed again. Patient developed hyponatremia. Patient left under medical advised in unstable condition.

Unenhanced CT image of the brain demonstrates bilateral subdural areas of hypoattenuation with compression of the frontal lobes.

Case 4

76 yrs old female, known case of HTN, HCV admitted in neurosurgery with diagnosis of right acute on chronic subdural for which burr hole evacuation was done. On 6th post op day patient developed shortness of breath, seizures and drowsiness. CT scan showed large volume of pneumocraium compressing the frontal lobes. Patient was diagnosed to have aspiration pneumonia. Patient improved on medications, regained her conscious level, follow up CT Scan done few days later showed resolution of pneumocranium. Patient was discharged as planned. No long term neurologic deficits were attributed to tension pneumocranium.



CT scan revealed large amount of intracranial air, representing pneumocephalus.

Case 5

22 yrs old female, admitted with complains of menstrual irregularities and high prolactin levels. She was diagnosed to have prolactinoma. Therefore trans-sphenoidal resection of tumor was planned and neuronavigation guided excision was done. Post-operative CT scan revealed large amount of intracranial air, representing pneumocephalus. Patient developed CSF leakage and trans-sphenoidal repair of CSF was done, but unfortunately she did not have any relief and complained of persistent CSF rhinnohea

CT scan with complex transverse fracture through the anterior cranial fossa with extensive tension pneumocranium and diffuse cerebral edema.

from left nostril and lumber drain was placed which drained more than a liter of fluid and CSF study was unremarkable for any impending infection. 48 hrs later there was no CSF rhinorrhea or post nasal dribbling. Patient was hemodynamically stable and was discharged home in stable condition with early follow up in clinic.

Case 6

45 yrs old male admitted after a road traffic accident bike versus truck, LOC and amnesia. On examination patient had diffuse CSF rhinorrhea bilaterally. Patient was admitted under the care of neurosurgery. CT scan showed complex transverse fracture through the anterior cranial fossa with extensive tension pneumocranium and diffuse cerebral edema. Patient was monitored with high flow oxygen and IV fluids. Surgery was planned for repair of defect in the anterior cranial fossa. After being haemodynamically and vitally stable, patient was discharged.

45-year-old male with Mount Fuji sign (extensive tension pneumocranium and diffuse cerebral edema).

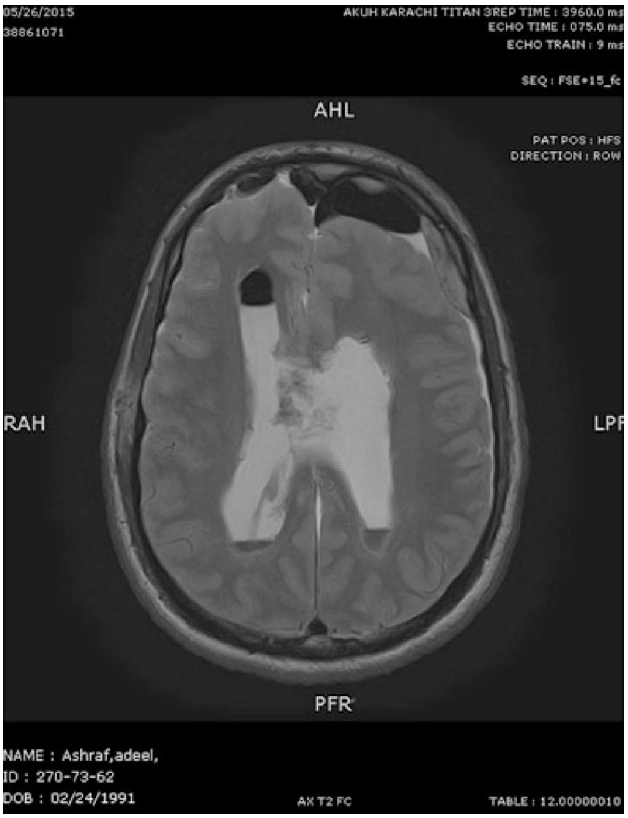
Case 7

73 yrs old elderly female known case of adenocarcinoma of lungs with brain metastasis, craniotomy was done for space occupying lesion. Post procedure her GCS kept on dropping, she was shifted to ICU. She was diagnosed with hospital acquired pneumonia and hyponatremia. MRI brain was advised which showed pneumocraium with compressing the frontal lobes bilaterally. Her conscious level further deteriorated, DNR code was decided by the family. Patient went in cardiopulmonary arrest and expired.

MRI brain shows pneumocraium with compressing the frontal lobes bilaterally

Case 8

26 yrs. old male patient admitted with complains of bilateral decreased vision, headache and vomiting for the past 2 months, underwent neuronavigation guided left frontal craniotomy with excision of space occupying lesion and EVD insertion. Post procedure MRI showed free air along frontal lobes giving Mount



MRI showed free air along frontal lobes giving Mount Fuji sign.

Fuji sign. Patient was shifted for intensive care unit for critical care. Patient improved clinically and was discharged. No long term neurologic deficits were noted.

Discussion

The most common location of pneumocephalus is in the subarachnoid and subdural spaces and the fewer sites for air collection include the intraventricular, intracerebral, and extradural spaces. Because of the peculiar meningeal anatomy of the anterior cranial fossa (the dura being thin and closely applied to bone and the arachnoid adherent to the frontal lobe), fronto-ethmoidal meningeal lacerations frequently results in subdural air collection. This intracranial air collection sometime can result in tension pneumopcephalus with characteristic Mount Fuji sign.[5]

When the clinical and imaging findings are correctly identified, treatment consists of emergent decompression to alleviate pressure on the brain parenchyma.

Careful monitoring for clinical signs of deterioration, as well as serial CT scanning of the brain, is recommended. In patients who are treated for tension pneumocephalus, resolution of the subdural air collection is expected.

The Mount Fuji sign on CT scans of the head in trauma patients and in postoperative patients can be a critical finding made by the radiologist. Identification of this sign can have immediate and important clinical implications for patient care and outcome.[2]

Potential neurosurgical procedures for treatment, include craniotomy, drilling of burr holes, needle aspiration, ventriculostomy placement, administration of 100% oxygen, and closure of dural defects.[6,7]

Another study shows, Comparison of external ventricular drain (EVD) catheter placement with a 14 French Foley catheter. There was, however, no increased risk in placing the catheter in the subgaleal space compared to an EVD catheter. It relieved the patient's symptoms and resulted in complete resolution of tension Pneumocephalus.[8]

Conclusion

More than 70% of pneumocephalus is related to trauma. It is commonly resulted from skull base or paranasal sinus fracture. Other causes include tumors, infection, surgery, spinal or epidural anesthesia and positive pressure ventilation.

Tension pneumocranium can behave like other intracranial mass lesions and cause worsening of the neurological status of patients. It is important to have a high index of suspicion to make the correct diagnosis as appropriate intervention will prevent morbidity and mortality in these patients.[9]

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