# *Case study*

**External lumbar drainage: An acceptable treatment for Traumatic Tension Pneumocephalus with CSF otorrhea**


## Abstract

Traumatic tension pneumocephalus (TTP) can be either asymptomatic or associated with CSF ottorhea or rhinorhea. TTP is a diagnosis conventionally made by radiological due to variety of clinical presentation. TTP can be either be treat by conservative or invasive therapeutic approach. We describe a case in which external lumbar drainage (ELD) performed to treat concomitant post-traumatic CSF otorrhea following TTP. He was diagnosed with TTP based on radiological finding on 6 hour post trauma and develop persistent right CSF otorrhea at post trauma day 5 requiring CSF diversion. However, to the best of our knowledge, there has been no case of TTP with CSF otorrhea treated with ELD as invasive therapeutic approach.



KEYWORDS: traumatic tension pneumocephalus with CSF otorrhea, external lumbar drain


## Introduction

Traumatic Tension Pneumocephalus (TTP) is an unusual but life-threatening neurosurgical emergency condition in which air steadily accumulates in the intracranial cavity and produces a mass effect on the surrounding brain parenchyma. Incidence of TTP is less than 1% in patients with head trauma, but it could reach 8% when fractures of either the paranasal sinus or the skull base presents (1). It was first reported by Luckett, where the TTP diagnosed after 1 weeks post trauma (2).

In this study, we will present a case of TTP with persistent CSF otorrhea that successfully treated with ELD.

## Case report

A 39 years old man had slipped and fell when he wanted to sit on a chair while he was having drinks of 2 shot of whisky with his friends. He fell on his right side and his face hitting the wall. Post trauma he sustained, bleeding from right ear and dizziness. Otherwise, he was well with a Glasgow Coma Scale (GCS) E4V5M6, score of 15, pupils were 3 mm bilaterally and reacting to light. No any cranial nerves, motor, and

sensory deficit detected. His vital signs remain stable, and other examination revealed unremarkable. He develop persistent right ear bleeding with slightly reduced hearing. Halo test positive show evidence of CSF leak or known as CSF otorrhea. Right ear examination revealed external acoustic meatus pooling of bloods with cotton ball 3/4 soaked hemoserous discharge. Tympanic membrane visualised appear intact with hemotympanum. Tympanometry show type B with normal ear canal volume suggesting middle ear effusion. Pure tone audiometry show mild to profound conductive hearing loss.

A plain computerized tomography (CT) was done which revealed extensive pneumocephalus predominantly at bifrontal subdural space,compressive the frontal lobes giving appearance of "Mount Fuji"sign with adjacent cerebral sulci effaced. Multiple air pockets also seen at the interhemispheric fissure, bilateral sylvian fissures, basal cisterns and along right tentorium cerebelli. Acute intraparenchymal bleeds at left frontal lobe with perihemorrhagic oedema. The subtle acute subarachnoid bleed at left frontal, left high parietal, bilateral temporal region and left sylvian fissure. Right occipital bone fracture and transverse fracture of mastoid part of the right temporal bone extending to anterior and posterior bony wall of the right mandibular fossa. No distruption of temporomandibular joint.

Repeat CT scan at post trauma day 2, no interval change of pneumocranium and no expanding intra-cranial bleed.He was treated conservatively with bed rest, oxygen therapy and laxatives to prevent further straining leading to increased intracranial pressure. At post trauma day 5,he remains well with full GCS (E4V5M6) with no more dizziness and no other symptom of increase intracranial pressure. However,symptom of CSF otorrhea persistent that caused him uncomfortable.

The patient was managed with external lumbar drainage at post trauma day 5. Upon placement of lumbar drainage, normal opening CSF pressure of 18cm H2O and keep external lumbar drainage for 3 days. The patient improved symptomatically, ear discharge subsided and the GCS score remain 15 (E4V5M6). Serial tympanometry and pure tone audiometry done show improvement with tympanometry show type A and normal pure tone audiometry. He was discharge after 12 days of admission. He was doing well at last follow up 3 months after the injury.

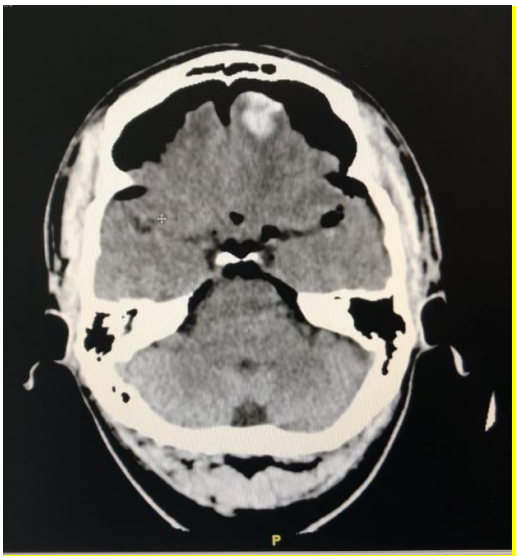

Figure 1: Parenchymal view of plain CT image show “Mount Fuji sign” with left frontal intraparenchymal bleed that separate the subdural layer.

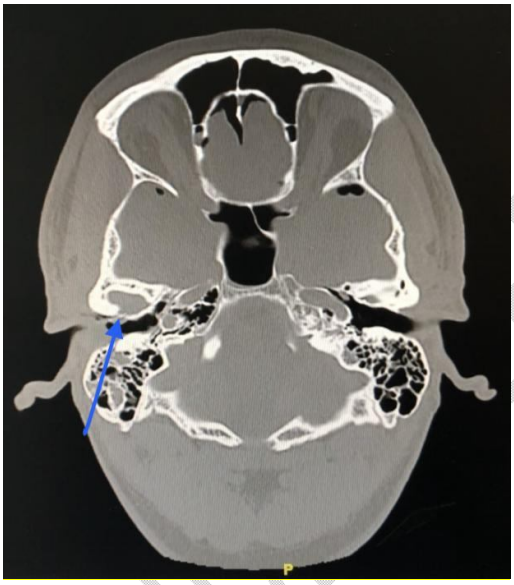

Figure 2: Bone view of plain CT image show transverse fracture of mastoid part of the right temporal bone extending to anterior and posterior bony wall of the right mandibular fossa (blue arrow).



**Discussion**

We are reporting a very rare condition of TTP with CSF otorrhea and was successfully treated symptomatically with ELD. Pneumocephalus often associated with cranial surgery or craniofacial fracture following a trauma known as traumatic pneumocepahalus. Traumatic pneumocephalus or also known as intracranial aerocele following a trauma is defined as presence of gas in the intracranial spaces, can occur in several compartments: extradural, subdural, subcrachnoid, intraventricular (pneumoventricle), extradural and intracerebral pneumatocoele.

In 1783, Alexander Monro and George Kellie describe that skull is a rigid compartment and the brain is nearly incompressible. Based of Monro-Kellie doctrine or hypothesis describes the relationship between the contents of the cranium and intracranial pressure. Any increase in the volume of one component necessitates a

decrease of the other components through compensatory mechanisms, an increase in intracranial pressure (ICP), or both. Thus, any increase of the contents of the cranium, will cause patient to develop sign and symptom of increase intracranial pressure.

The golden standard diagnostic tool for pneumocephalus is often by radiological finding of CT scan. Even minor facial trauma leads to sign and symptom of increase intracranial pressure will give positive CT scan finding. However, clinicians need to be wary for signs of associated increased intracranial pressure as well as to be aware that if the air leak is ongoing, stable patients may progress to tension pneumocephalus. If the air is subdural, CT scan of the brain will show a ‘‘Mount Fuji sign,’’ which occurs when the air causes both compression and separation of the brain’s frontal lobes. If the air is epidural, as demonstrated in our patient’s imaging, the pneumocephalus will take on the biconvex shape as the dura is stripped away from the inside of the skull via the tension, similar to an epidural hematoma (3). Nevertheless, our patient manifest the sign of Mount Fuji which suggested that air filled in subdural space with separation of intraparenchymal bleed at left frontal lobes that show in figure 1.

Tension pneumocephalus may develop if the intracranial air creates a mass effect on the brain, resulting in a possibly life-threatening neurosurgical emergency, which needs to undergo immediate surgical or conservative treatment. Two mechanisms have been postulated to account for the entrance of air into the cranial vault. The Dandy theory of “ball-valve mechanism” was previously describes a unidirectional air movement from outside into the cranial cavity, which then gets trapped.This ball-valve effect with air being forced through the area of a craniodural defect from coughing, sneezing or other sudden changes in nasopharyngeal pressure. When the pressure wave subsides the defect is tamponaded by the brain. Repeated episodes may lead to elevated intracranial pressure because no associated CSF leakage can occur. Another theory of Horowitz “Inverted-soda-bottle effect”may be due to excessive leak of cerebrospinal fluid (CSF) causing a slightly negative intracranial pressure. As a result, air is drawn into the cranial cavity. This has been likened to the entry of air into an inverted bottle of water as the fluid escapes. The latter is most common during neurosurgical procedures (4, 5).

Signs and symptoms of pneumocephalus may be quite minor, but occasionally may be serious. The presenting signs and symptoms include headache, CSF rhinorrhoea or otorrhoea, seizure disorder and succussion-splash (6). Based on *Pillai P et al, a comprehensive literature review done in 2017,* there are no reports large enough to characterize the incidence of presenting symptoms in patients with Tension pneumocephalus, certain generalizations may be made based on pneumocephalus literature alone. This review show that headache was the most common, but not universally present, presenting symptom of tension pneumocephalus (seen in 44% of cases). This is consistent with previously published data, wherein headache was also found to be the most common, but not predominant, symptom (38% of cases) of pneumocephalus (7). A comparable degree of similarity can also be seen between the current review and previously reported data in terms of the incidence of CSF

rhinorrhea (41% versus 31%). Nonetheless, the only symptom and physical finding that is pathognomonic of pneumocephalus is the *bruit hydroaérique* (a.k.a. "succussion splash"), defined as the presence of a splashing sound heard only by the patient upon postural change (6). However, *bruit hydro-aérique* occurs in only about 7% of pneumocephalus cases. Mental status changes were associated with 44% of traumatic pneumocephalus cases in the current report, with 28% experiencing loss of consciousness at some point during their clinical course.

In our cases, tension pneumocephalus was developed in blunt trauma which manifested with minor sign and symptom such as dizzines and CSF ottorhea. CT finding show Right occipital bone fracture and transverse fracture of mastoid part of the right temporal bone extending to anterior and posterior bony wall of the right mandibular fossa. This radiological finding show tranverse temporal bone fracture but our patient clinical finding of otorrhea and otoscopy examination show hemotymponium and tympanometry show type B with normal ear canal volume. The initial pure tone audiometry show mild to profound conductive hearing loss. Serial tympanometry and pure tone audiometry done show improvement before patient discharge. The sequelae of temporal bone fracture is hemotymphanium. However, CSF otorrhea frequently observed with longitudinal temporal bone fracture.CSF Otorrhea that is associated with a transverse temporal bone fracture post trauma is a rare presentation. The US Centers for Disease Control and Prevention (CDC) reports that such fractures occur in 3 out of 100,000 emergency room visits and fewer than 0.1% of patients with otolaryngology trauma require otorrhea management (8)

The therapeutic approach to tension pneumocephalus includes a complex of manipulations directed to removing of intracranial air mass effect, adequate skull base defects closure, and secondary posttraumatic meningitis prophylaxis. The initial treatment is usually conservative, including nursing in head-up position, high concentration oxygen, avoidance of maneuvers that might increase intra-sinus pressures (such as nose-blowing or valsalva maneuver) and antibiotics if there is evidence of meningsm. Surgical treatment is indicated when there is recurrent pneumocephalus, or signs of increasing intracranial pressure suggesting development of tension pneumocephalus (9).

However, there are no reported cases of TTP with CSF otorrhea treated with a external lumbar drain. However, there have been several reports of traumatic tension pneumocephalus treated with a lumbar drain. In one case, a patient with traumatic pneumocephalus and CSF otorrhea was treated with a lumbar drain and a ventriculoperitoneal shunt. The patient had a good outcome and the CSF otorrhea resolved (10). When placing a lumbar drain in a patient with traumatic pneumocephalus, it is important to be cautious. The procedure should be done under the guidance of a qualified healthcare professional, and the patient should be monitored closely for any signs of complications. The patient should also be placed in a position that will minimize the risk of further injury or damage to the brain. Additionally, the patient should be given adequate pain relief and sedation to ensure their comfort during the procedure. Voursh was the first to use a lumbar drainage

system in 1963 and the success rate of this system was reported to be between 85 and 94 % by different authors (11) .

Fortuitously, there are few complications related to the use of ELD or also known as continous lumbar drain system. These complications are divided into three categories by Acikbas et al.: A) complications related to alterations in CSF drainage rate, B) complications due to mechanical failure of the catheter, and C) infections. In order to prevent complications A and B, CSF must be intermittently drained with a total daily amount of 150 – 250 mL, the position of the reservoir must be elevated to prevent a pressure gradient, and a multiperforated silicone catheter must be used to avoid system failure. The last and most complicated group of ELD complications includes meningitis the incidence of which is estimated to be about 10 % (12) . This estimated risk is a total risk involving the risk of CSF leakage related to rhinorrhea and otorrhea plus the risk of a foreign ELD catheter. Therefore, it is difficult to determine whether the meningitis detected in these cases resulted from rhinorrhea/ otorrhea or the foreign catheter (12) . Puzilli et al. studied cytochemical and microbiological analyses of CSF and the catheter and reviewed the safety of this analysis regardless of the duration of treatment. They preferred to continue ELD for 10 days with a combined antibiotic treatment for identified microorganism instead of catheter removal. They reported an average daily cell count of 80 which is higher than our series; however, they reported an inconsistent lower rate of systemic or local infection (13) .

Dalgic A et al recommend commencement of meningitis treatment besides from removal of the ELD. Surgical intervention should be considered for cases having continuing rhinorrhea/ otorrhea. Of three cases with ELD and cell counts over 30, two were surgically treated with duraplasty as well as combined meningitis treatment. CSF leakage could be treated successfully by ELD, which is a less invasive technique. The risk of developing meningitis is not higher than that of the spontaneously stopped, conservative or surgically treated groups. Eventually, morbid and mortal complications like meningitis could be prevented with a simple daily CSF cell count (14).

In conclusion, TTP is rare, tends to be associated with cranial base and facial injuries, and can be present following both blunt and penetrating mechanisms of injury. Computed tomography is the gold standard for diagnosis of this condition. ELD is an acceptable approach of treatment of TTP with CSF otorrhea with minimal risk where the benefit outweight the risk. our patient had a good outcome and the CSF otorrhea resolved.

**Reference**

1. Al-Aieb A, Peralta R, Ellabib M, El-Menyar A, Al-Thani H. Traumatic tension pneumocephalus: two case reports. International journal of surgery case reports. 2017 Jan 1;31:145-9.

2. Luckett WH. Air in the ventricle of the brain follow of the skull. J New Ment Dis. 1913;40:326-8.
3. Thapa A, Agrawal D. Mount Fuji sign in tension pneumocephalus. Indian J Neurotrauma 2009;6:161-2
4. Jacobs JB, Persky MS. Traumatic pneumocephalus. The Laryngoscope. 1980 Mar;90(3):515-21.
5. L'Hommedieu LM, Dingeldein MW, Tomei KL, Kilbane BJ, Acute management of tension pneumocephalus in a pediatric patient: a case report. J Emerg Med. 2018;54(1): 112-5
6. Markham JW. The clinical features of pneumocephalus based upon a survey of 284 cases with report of 11 additional cases. Acta Neurochir (Wien) 1967;16:1-78.
7. Pillai P, Sharma R, MacKenzie L, Reilly EF, Beery PR, Papadimos TJ, Stawicki SP. Traumatic tension pneumocephalus–Two cases and comprehensive review of literature. International journal of critical illness and injury science. 2017 Jan;7(1):58.
8. CDC. (2019). Otolaryngology Emergencies. Retrieved from https://emergency.cdc.gov/otolaryngology/
9. Leong KM, Vijayananthan A, Sia SF, Waran V. Pneumocephalus: An uncommon finding in trauma. Med J Malaysia 2008;63:256-8.
10. Kadakia, M., & Abecassis, H. (2020). Successful management of traumatic pneumocephalus and CSF otorrhea with a lumbar drain and ventriculoperitoneal shunt. Surgical Neurology International, 11(1), 1-4.
11. Vourch G . Continuous cerebrospinal fl uid drainage by indwelling spinal catheter . Br J Anaesth 1963 ; 35 : 118 – 120
12. Acikbas SC , Akyuz M , Kazan S , Tuncer R . Complications of closed continuous lumbar drainage of cerebrospinal fl uid . Acta Neurochir 2002 ; 144 : 475 – 480
13. Puzzilli F , Mastronardi L , Farah JO , Ruggeri A , Ltmardi P . Cytochemical and microbiological testing of CSF and catheter in patients with closed continuous drainage via a lumbar subarachnoid catheter for treatment or prevention of CSF fi stula . Neurosurg Rev 1998 ; 21 : 237 – 242
14. Dalgic A, Okay HO, Gezici AR, Daglioglu E, Akdag R, Ergungor MF. An effective and less invasive treatment of post-traumatic cerebrospinal fluid fistula: closed lumbar drainage system. min-Minimally Invasive Neurosurgery. 2008 Jun;51(03):154-7.