



## Case Report

# Endoscopic treatment of tension pneumocephalus secondary to traumatic cerebrospinal fluid rhinorrhea: case report and review of literature

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**Background:** *Pneumocephalus is the presence of air within the skull. Tension pneumocephalus develops whenever air inside the skull accumulates or is under pressure. Endoscopy is frequently used in the management of cerebrospinal fluid leak however rarely used for the treatment of tension pneumocephalus.*

**Case Description:** *We present a case of a 64-year-old man diagnosed with a right frontal depressed skull fracture. He underwent a craniotomy, however a second Computerized Tomography revealed the emergence of a tension pneumocephalus. After 3 successive endoscopic surgeries, the patient showed complete recovery.*

**Discussion:** *The present case proved once again the efficiency of endoscopy in treating pneumocephalus. The presenting causes, symptoms and treatment options for pneumocephalus are reviewed.*

**Keywords:** *Tension pneumocephalus, endoscopic repair, CSF leak, head trauma.*

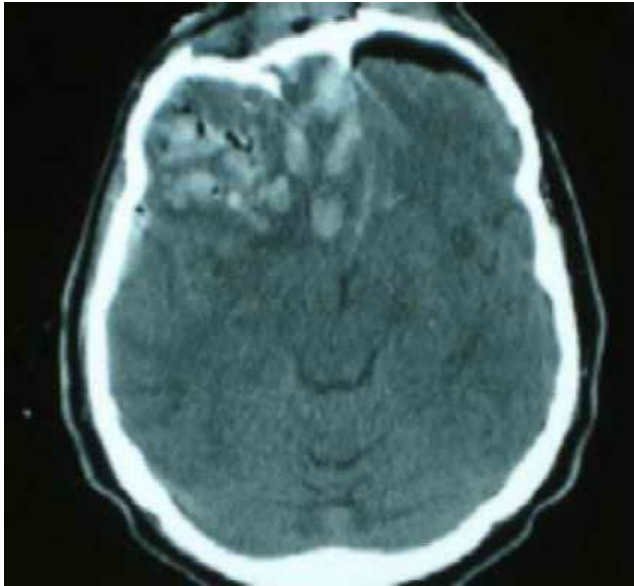
## INTRODUCTION

Pneumocephalus, one of the uncommon complications of traumatic head injury, is defined by the presence of air or gas within the cranial cavity. Tension pneumocephalus is the presence of intracranial air under pressure associated with increased intracranial pressure, causing a significant mass effect and resulting in rapid neurological deterioration. Although endoscopic techniques are frequently used for the diagnosis and management of the CSF leak, it is not described in the literature in the cure of tension pneumocephalus [1]. We report a case of traumatic tension pneumocephalus that was successfully

treated by endoscopy after failure of the repair through an intracranial approach.

## CASE DESCRIPTION

A 64-year-old man, suffering from hypertension and coronary artery disease, presented to the Emergency Room two hours after sustaining a motor vehicle accident that resulted in severe closed head injury. The brain CT scan demonstrated a right frontal depressed skull fracture, frontal lobe contusions as well as orbital roof and frontal sinus fractures (Fig. 1). The patient underwent a craniotomy for elevation of the depressed skull fracture.



**Fig 1. Axial parenchymal window of a right frontal depressed skull fracture with underlying frontal lobe contusions and pneumocephali.**



**Fig 2. Axial view of pneumocephalus along with hydrocephalus.**

The intraoperative findings were consistent with dural laceration and underlying brain contusions. The intraoperative surgery was completed with right frontal sinus cranialization and duraplasty with galeal graft. The patient made a good recovery and was discharged home in few days.

He presented one month later with headache, vomiting and decreased level of consciousness. A repeated brain CT scan showed a large pneumocephalus. The patient underwent a revision of the previous craniotomy as well as a repair of the CSF leak with a fascia lata graft.

Two weeks later the patient presented with acute deterioration and a third brain CT scan revealed the resurgence of pneumocephalus along with a significant hydrocephalus (Fig. 2). The clinical and radiological pictures were consistent with tension pneumocephalus. The patient underwent insertion of a programmable ventriculo-peritoneal shunt followed by an endoscopic repair of the right cribriform plate defect using both temporalis fascia and muscle graft with fibrin glue. The closure of skull base defect was guided by the site of CSF leak seen on CT Scan as well as by palpating the defect (~ 4 mm) and following the leak intraoperatively.

Postoperatively, the patient improved gradually and the following CT scan showed a complete resolution of the pneumocephalus.

One month later, the patient presented with high-grade fever, pneumonia, shunt infection and neurological deterioration. A ventriculostomy catheter was inserted and the ventriculo-peritoneal shunt was removed. Further radiologic work up (CT mitrazamide study) showed another site of CSF leakage on the left side (Fig. 3). The patient underwent a second endoscopic repair of the left site leakage using both temporalis fascia and muscle graft in multilayer fashion and overlay technique with fibrin glue. After the procedure the pneumocephalus resolved however the clinical state of the patient deteriorated three weeks later. A new right-sided leak required a third endoscopic procedure using the same technique. The patient was discharged home in stable condition two weeks later after he completed the course of antibiotic therapy. Follow up CT scan three months later showed complete resolution of the pneumocephalus (Fig.4).



**Fig 3. CT cisternography: Complex fracture involving the anterior skull base and CSF leak seen at the level of the cribriform plate and crista galli on the left side.**



**Fig 4. Complete resolution of pneumocephalus.**

## DISCUSSION

Chiari discovered and described pneumocephalus in 1814 while undergoing an autopsy and Lockett provided the first radiograph of pneumocephalus in 1913.<sup>(2)</sup> The dura matter joining the frontal areas is thin and attached along the olfactory nerves. Fractures in the frontal region could tear the dura matter and consequently form fistulous tracts; external air enters the skull through tracts, engendering pneumocephalus.<sup>(1)</sup>

Iatrogenic or idiopathic disorders, neoplasm and infections (such as intracranial infections: a cerebral abscess with gas-forming organisms) could result in pneumocephalus; the site of pneumocephalus could be epidural, subdural, subarachnoidal or intracerebral.<sup>(3)</sup>

Many studies reported the emergence of pneumocephalus among patients who underwent CSF shunting.<sup>(4,5)</sup> Different types of shunts including pleural, peritoneal, and atrial usually result in delayed pneumocephalus.<sup>(6-7)</sup> Moreover, patients exposed to mastoidectomy, radiotherapy, epidural anesthesia or even lumbar puncture could develop pneumocephalus.<sup>(8-11)</sup> Symptoms of pneumocephalus include CSF leak, headache, vertigo, vomiting, aphasia, dysphasia, hemiparesis, orbital signs, anosmia, meningitis, and a splashing sound only audible to the patient when he rapidly changes the head's position.

Two mechanisms could be responsible for the emergence of pneumocephalus the "ball-valve" effect, where an increase in pressure (sneezing or coughing) forces the air into the cranium through a fistulous tract<sup>(1)</sup> and the "inverted bottle", where a fistulous tract leaks the CSF: as the liquid escapes, air enters the empty space replacing the lost liquid to compensate for negative pressure.<sup>(12)</sup>

Both intra and extracranial techniques were discovered and developed by Dandy (1926) and Dohlman (1948) to repair CSF leaks. Dandy was the first to repair a case of rhinorrhea through bifrontal craniotomy [1]. Both practices appeared to be successful, however the intracranial approach seemed to be more invasive and could involve the loss of smell, postoperative intracerebral hemorrhage, cerebral oedema, epilepsy, frontal lobe dysfunction accompanied by memory and concentration deficits and potential osteomyelitis of the frontal bone flap.<sup>(13-15)</sup> Wigand (1981) and Stankiewicz (1989) were the first to describe endoscopic closures of the CSF leaks. Only two studies have reported treating tension pneumocephalus by endoscopy.<sup>(1)</sup> The intracranial approach is still considered the first line of treatment.

The case previously presented ensures that endoscopy is a safe and efficient technique for the management of tension pneumocephalus. The severe anterior cranial fossa injury resulted in the dural tear and pneumocephalus lately emerged. By closing the skull base defect complete

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cessation of the CSF leak occurs with gradual absorption of the air and resolution of pneumocephalus. For small defect (less than 2cm) we prefer using temporalis fascia and muscle as grafting material in a multi-layer fashion as an extracranial overlay technique; fibrin glue is also used to achieve complete seal. For larger defect we would require bone and or cartilage graft to achieve complete closure as well as it acts as a support for the brain to prevent encephalocele.

Multiple surgical endoscopies are sometimes necessary due to the fact that as a defect is repaired a second one would appear revealing itself by both the csf leak as well as the appearance of the pneumocephalus.

Our patient underwent 2 craniotomies, however rapid neurological recovery did not happen until the patient went through three endoscopic repairs. Follow up CT scans showed a complete recovery from the pneumocephalus.

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