Case Report

Tension pneumocephalus from skull base surgery: A case report and review of the literature

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Abstract

Background: Tension pneumocephalus from skull base surgery is a rare occurrence that mandates urgent neurosurgical attention.

Case Description: We describe a case of tension pneumocephalus secondary to an endoscopic endonasal resection of an adamantinomatous craniopharyngioma and how it was successfully managed at our institution.

Conclusion: Our experience reflects that definitive treatment of tension pneumocephalus is required with multilayered dural repair, but temporising measures should be used immediately to prevent neurological deterioration prior to the definitive repair.

Key Words: Dural repair, skull base surgery, tension pneumocephalus

BACKGROUND

Tension pneumocephalus (TP) is a rare complication of skull base surgery and can lead to rapid neurological deterioration. Significant amounts of intracranial air can compress and displace the intracranial structures, necessitating urgent decompression. While options exist for the management of TP, the treatments are only described in case reports or case series. We report here a case of TP secondary to an endoscopic endonasal resection of an adamantinomatous craniopharyngioma, and how it was managed successfully at our institution. We hope to use the information learnt from this case, in combination with a review of the literature, to create a guide for the management of TP secondary to skull base surgery.

CASE REPORT

The patient is a 57-year-old female who presented with 5 months of progressively worsening visual acuity and diabetes insipidus. Magnetic resonance imaging (MRI) showed a heterogeneous rim-enhancing 17 × 13 × 25 mm suprasellar lesion. The patient has no significant medical comorbidities. An endoscopic endonasal resection of the lesion was performed. DURAFOAM dural graft implant was used to close the dura and a nasoseptal flap was placed over the defect. The lesion was confirmed on pathology to be an adamantinomatous craniopharyngioma. Day 1 postoperative computed tomography of the brain (CTB) showed a small bifrontal pneumocephalus [Figure 1a]. Two days postoperatively, the patient developed...
rhinorrhoea and lower limb diplegia. CTB demonstrated an expanding pneumocephalus with mass effect [Figure 1b]. This was decompressed via bilateral frontal burr holes and CTB showed a slight reduction in the volume of the pneumocephalus [Figure 1c]. Four days after the operation, her Glasgow Coma Scale (GCS) again deteriorated to 10 (M6V1E3) with lower limb diplegia. Percutaneous aspiration of the pneumocephalus via bilateral frontal burr holes was performed. The aspiration continued until the patient started to verbalize and move her lower limbs.

A transnasal transphenoidal repair of the dural defect was performed. Dural substitute was removed and a fascia lata graft inlay was used to repair the defect. However, the negative intracranial pressure drew the fascia lata graft intradurally. A fascia lata onlay graft with autologous blood patch was then used and the nasoseptal flap was replaced and secured with a TISSEEL fibrin sealant. Ten hours after the operation, the patient’s GCS dropped to 11 (M6V1E4) and CTB again showed re-accumulation of the pneumocephalus. Percutaneous aspiration was performed and the patient returned to her neurological baseline.

Three days after the last percutaneous aspiration, rhinorrhoea was again observed. This was followed 2 days later by another episode of GCS reduction to 13 (M6V3E4) with diplegia. CTB showed an expanding anterior pneumocephalus with mass effect. Percutaneous aspiration was performed with GCS recovery. The following day, GCS dropped to 9 (M6V2E1), and percutaneous aspiration was again performed for improvement in GCS. An endoscopic repair of the CSF leak was performed. During the operation, a leak was found between the leaflets of the previous fascia lata repair. A fat bath plug was placed over the defect with a large single piece of fascia overlaid. The repair was then tested with Valsalva three times. The nasoseptal flap was overlaid and augmented with a left inferior turbinate free mucosal graft. Postoperative CTB showed a significant reduction in the size of the pneumocephalus [Figure 1d]. The patient made an uneventful recovery and discharged GCS 15 with no neurological deficit.

**DISCUSSION**

Pneumocephalus is the presence of air or gas within the cranial vault usually as a result of a breach in the craniodural barrier. It is thus a common entity following neurosurgical intervention with a predominantly clinically benign course and expectant management.\(^2\) TP is a clinical emergency in which the pneumocephalus produces intracranial hypertension and subsequent mass effect leading to rapid neurological deterioration and herniation that can manifest clinically as reduction in the level of consciousness (LOC), focal neurological symptoms, seizures, and death.\(^17\) This case contributes to the literature of reported cases of TP complicating skull base surgery and provides additional insight to its management.

There are two proposed mechanisms for the development of TP. The first is a “ball-valve” mechanism that allows air to enter but not exit the cranial vault through a defect during a cough or sneeze. The second is the “inverted pop bottle” mechanism whereby the air enters the intracranial compartment to equalize the pressure differential as cerebrospinal fluid (CSF) exits through the defect.\(^11\) The mechanism of action behind the formation of TP thus justifies the importance of repairing the dural defect. Even when the defect is 1 mm, the accumulation of air within the intracranial compartment can progress to TP.\(^4\) While dural repair is the definitive treatment for TP in skull base surgery, and this is certainly reflected in the literature review performed using Medline as shown in Table 1,\(^3,6,7,13-16\) temporising measures are often required to manage neurological deterioration and prevent permanent neuronal damage prior to the institution of definitive treatment.

A wide range of temporising measures for TP have been described. Conservative approaches include bed rest, raising the bed head, hyperosmolar therapy, and abstaining from Valsalva or similar manoeuvres.\(^1,5\) The use of normobaric hyperoxia with 100% inspired oxygen facilitates faster resorption of pneumocephalus and has been described in the literature.\(^10\) However, 100% FiO2 can only be tolerated for 24 to 48 hours due to pulmonary toxicity.\(^12\) Medical management alone is often inadequate for even temporising the neurological deterioration. Surgical temporising options, which provide rapid decompression of the pneumocephalus, include needle aspiration, drilling of burr holes, craniotomy, and ventriculostomy.\(^10\)

![Figure 1: (a) Day 1 post-operative CTB; (b) Expanding pneumocephalus with mass effect; (c) Slight reduction in volume of pneumocephalus; (d) Significant reduction in size of pneumocephalus](image-url)
From the results of the literature review shown in Table 1 and our case, it is evident that the initial closure with a single layer of fascia lata without glue was too not strong enough to repair the defect. The use of multilayered closure with fibrin glue for the second attempt was successful. This finding was echoed in Aksoy et al.’s study whereby multilayered closure with adipose tissue, fascia lata, and glue was used to successfully repair a 1 mm defect. Therefore, we suggest to treat dural defects in TP secondary to skull base surgery via a multilayered technique consolidated by fibrin glue irrespective of the size of the defect.[5]

Another learning point from our case was the use of the Valsalva manoeuvre intraoperatively following closure of the dural defect to check for CSF leakage. This was not performed during the first operation which was unsuccessful in treating the pneumocephalus, but was performed in the second operation during which the dural defect was successfully closed. Theoretically, Valsalva expels intrathoracic blood to cause an increase in intracerebral pressure (ICP) which promotes spillage of CSF from the intracranial compartment if a dural defect exists.[9] We thus advocate for its use at the end of the operation to test the integrity of the repair.

TP secondary to skull base surgery is a rare complication that can be accompanied by acute neurological deterioration. The definitive treatment of TP is dural repair, but temporising measures should be used to prevent neurological deterioration prior to the definitive repair. Dural repair should be performed using a multilayered approach with consolidation from fibrin glue, and the Valsalva manoeuvre should be performed at the end of the repair to assess its integrity.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Compliance with ethical standards

Conflicts of interest
There are no conflicts of interest to disclose.

Informed consent
Informed consent was obtained from the patient.

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