

## Case Report

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

Charlotte Yin, Bi Yi Chen<sup>1</sup>Department of Nuclear Medicine, St. Vincent's Hospital, Darlinghurst, <sup>1</sup>Faculty of Medicine, University of Sydney, Camperdown, New South Wales, AustraliaE-mail: Charlotte Yin - [charlotte.yin@gmail.com](mailto:charlotte.yin@gmail.com); \*Bi Yi Chen - [chen.m.biyi@gmail.com](mailto:chen.m.biyi@gmail.com)

\*Corresponding author

Received: 21 March 18 Accepted: 18 May 18 Published: 04 July 18

## 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**Access this article online****Website:**[www.surgicalneurologyint.com](http://www.surgicalneurologyint.com)**DOI:**

10.4103/sni.sni\_91\_18

**Quick Response Code:**

## 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

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** [reprints@medknow.com](mailto:reprints@medknow.com)

**How to cite this article:** Yin C, Chen BY. Tension pneumocephalus from skull base surgery: A case report and review of the literature. *Surg Neurol Int* 2018;9:128. <http://surgicalneurologyint.com/Tension-pneumocephalus-from-skull-base-surgery:-A-case-report-and-review-of-the-literature/>

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

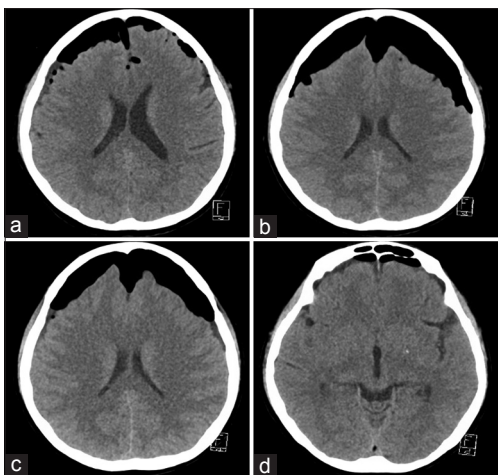
tested with Valsalva three times. The nasoseptal flap was overlaid and augmented with a left inferior turbinate free mucosal graft. Postoperative CTB showed a significant reduction in the size of the pneumocephalus [Figure 1d]. The patient made an uneventful recovery and discharged GCS 15 with no neurological 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.<sup>[2]</sup> 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.<sup>[17]</sup> 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.<sup>[11]</sup> 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.<sup>[4]</sup> 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,<sup>[3,6,7,13-16]</sup> 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.<sup>[1,8]</sup> The use of normobaric hyperoxia with 100% inspired oxygen facilitates faster resorption of pneumocephalus and has been described in the literature.<sup>[10]</sup> However, 100% FiO<sub>2</sub> can only be tolerated for 24 to 48 hours due to pulmonary toxicity.<sup>[12]</sup> 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.<sup>[10]</sup>



**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**

**Table 1: Cases of tension pneumocephalus due to skull base surgery**

Author	Year	Aetiology	Treatment	Outcome
Clevens <i>et al.</i> <sup>[6]</sup>	1994	Endoscopic sinus surgery	Bifrontal craniotomy, repair of defect with pericanial flap, and placement of lumbar drain	Uneventful recovery
Chou <i>et al.</i> <sup>[4]</sup>	2006	Left nasal polypectomy and mucoperichondrial repair of CSF leak	Bifrontal craniotomy and needle aspiration	Uneventful recovery
Ruiz-Juretschke <i>et al.</i> <sup>[15]</sup>	2007	Transphenoidal surgery	External ventricular drainage, anterior nasal tamponade, and repair of dural defect	Uneventful recovery
Emmez <i>et al.</i> <sup>[7]</sup>	2009	Endoscopic sinus surgery	Bifrontal craniotomy and repair of dural defect	Uneventful recovery
Pruss <i>et al.</i> <sup>[14]</sup>	2011	Ethmoid sinus surgery	Revision of dural air leak via duroplasty	Uneventful recovery
Aksoy <i>et al.</i> <sup>[1]</sup>	2013	Endoscopic sinus surgery	Burrhole and repair of defect in the ethmoid roof with multiple layers of adipose tissue, fascia lata graft and fibrin glue	Uneventful recovery
Simmons <i>et al.</i> <sup>[16]</sup>	2013	Endoscopic sinus surgery	Right frontal burr hole, ethmoidectomy and dural repair	No neurological improvement
Mamis <i>et al.</i> <sup>[13]</sup>	2013	Endoscopic transplanum transtuberulum approach for resection of a suprasellar epidermoid tumor	Insertion of EVD and repair of dural defect with fascia lata and repositioning of the pedicle nasoseptal flap	Uneventful recovery
Celikoglu <i>et al.</i> <sup>[3]</sup>	2016	Endoscopic sinus surgery	Craniotomy and repair of defect with galea and fibrin glue	Uneventful recovery

CSF: Cerebrospinal fluid, EVD: External ventricular drain

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.<sup>[5]</sup>

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.<sup>[9]</sup> 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.

### Funding

No funding was received for this research.

### Compliance with ethical standards

### Conflicts of interest

There are no conflicts of interest to disclose.

**Informed consent** Informed consent was obtained from the patient.

### REFERENCES

1. Aksoy F, Dogan R, Ozturan O, Tugrul S, Yildirim YS. Tension pneumocephalus: an extremely small defect leading to an extremely serious problem. *Am J Otolaryngol* 2013;34:749-52.
2. Babl FE, Arnett AM, Barnett E, Brancato JC, Kharasch SJ, Janecka IP. Atraumatic pneumocephalus: A case report and review of the literature. *Pediatr Emerg Care* 1999;15:106-9.
3. Celikoglu E, Hazneci J, Ramazanoglu AF. Tension pneumocephalus causing brain herniation after endoscopic sinus surgery. *Asian J Neurosurg* 2016;11:309-10.
4. Chou S, Ning M, Buonanno F. Focal intraparenchymal tension pneumocephalus. *Neurology* 2006;67:1485.
5. Church CA, Chiu AG, Vaughan WC. Endoscopic repair of large skull base defects after powered sinus surgery. *Otolaryngol Head Neck Surg* 2003;129:204-9.
6. Clevens RA, Bradford CR, Wolf GT. Tension pneumocephalus after endoscopic sinus surgery. *Ann Otol Rhinol Laryngol* 1994;103:235-7.
7. Emmez H, Durdag E, Uslu S, Pasaoglu A, Ceviker N. Intracerebral tension

- pneumocephalus complicating endoscopic sinus surgery: Case report. *Acta Neurochir (Wien)* 2009;151:1001-2.
8. Goldmann RW. Pneumocephalus as a consequence of barotrauma. *JAMA* 1986;255:3154-6.
  9. Haldar R, Khandelwal A, Gupta D, Srivastava S, Rastogi A, Singh PK. Valsalva maneuver: Its implications in clinical neurosurgery. *Neurol India* 2016;64:1276-80.
  10. Hong B, Biertz F, Raab P, Scheinichen D, Ertl P, Grosshennig A, et al. Normobaric hyperoxia for treatment of pneumocephalus after posterior fossa surgery in the semisitting position: A prospective randomized controlled trial. *PLoS One* 2015;10:e0125710.
  11. Horowitz M. Intracranial Pneumocoele. An Unusual Complication Following Mastoid Surgery. *J Laryngol Otol* 1964;78:128-34.
  12. Klein J. Normobaric pulmonary oxygen toxicity. *Anesth Analg* 1990;70:195-207.
  13. Mammis A, Agarwal N, Eloy JA, Liu JK. Intraventricular tension pneumocephalus after endoscopic skull base surgery. *J Neurol Surg A Cent Eur Neurosurg* 2013;74(Suppl 1):e96-99.
  14. Pruss H, Klingebiel R, Endres M. Tension pneumocephalus with diplegia and deterioration of consciousness. *Case Rep Neurol* 2011;3:48-9.
  15. Ruiz-Juretschke F, Mateo-Sierra O, Iza-Vallejo B, Carrillo-Yague R. Intraventricular tension pneumocephalus after transsphenoidal surgery: A case report and literature review. *Neurocirugia (Astur)* 2007;18:134-7.
  16. Simmons J, Luks AM. Tension pneumocephalus: An uncommon cause of altered mental status. *J Emerg Med* 2013;44:340-3.
  17. Sweni S, Senthilkumaran S, Balamurugan N, Thirumalaikolundusubramanian P. Tension pneumocephalus: A case report with review of literature. *Emerg Radiol* 2013;20:573-8.