



## Case Report

# Extensive tension pneumocephalus presented in the setting of a challenging etiology

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## ABSTRACT

**Background:** Pneumocephalus (PNC) is a well-described consequence in postoperative settings and skull fractures that is usually self-limiting. It can get complicated into tension PNC on some rare occasions, leading to an intracranial mass effect. PNC was also reported after unintentional dural puncture throughout the epidural anesthesia process. However, tension PNC resulting from epidural anesthesia procedures is an extremely rare outcome that implies urgent intervention to relieve the tension within the brain. Here, we report a case of an extensive tension intraventricular PNC 2 days following an epidural anesthesia procedure for a femur fixation surgery.

**Case Description:** A 23-year-old male presented to the emergency department with basal skull fractures and a femur fracture due to a motorcycle accident. His skull base fracture was managed conservatively then he underwent a femur fixation procedure under epidural anesthesia. Two days after, he developed a severe headache with a disturbed level of consciousness. Computed tomography of the brain revealed an extensive PNC that involved all the subarachnoid spaces down to the cervical region and compressing the cerebellum, which was not found in the initial imaging. The patient's status improved after the twist-drill burr-hole evacuation of air under the water seal.

**Conclusion:** Extensive tension PNC can occur after traumatic brain injury, especially after epidural anesthesia. Such cases should gain high focus because they may differ from simple PNC regarding diagnosis, treatment, and follow-up.

**Keywords:** Epidural anesthesia, Intraventricular arachnoid, Pneumocephalus, Traumatic brain injury, Tension pneumocephalus

## INTRODUCTION

Pneumocephalus (PNC) is defined as the asymptomatic existence of air inside the cranium, including any of the epidural, subdural, subarachnoid, intracerebral, or intraventricular compartments.<sup>[3]</sup> It is a usual finding following trauma and surgical procedures.<sup>[5]</sup> However, symptomatic PNC, better known as Tension PNC, is a life-threatening condition requiring urgent intervention due to the intracranial mass effect.<sup>[2]</sup> Tension PNC, although extremely rare,

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could be a severe complication of unintended dural puncture and injection of air inside the subarachnoid or the subdural spaces throughout the epidural anesthesia process.<sup>[10]</sup> Tension intraventricular PNC, on the other hand, is a rare type of intraventricular PNC.<sup>[16]</sup> It is reported in the literature as a complication of cerebrospinal fluid (CSF) diversion procedures or excision of ventricular tumors.<sup>[8,17]</sup> This type of complication after spinal procedures is an unfamiliar clinical entity.

Here, we report a case of an extensive tension intraventricular PNC 2 days following an epidural anesthesia procedure for a femur fixation surgery.

### CASE DESCRIPTION

A 23-year-old male presented to the emergency department after encountering a motor vehicle accident that resulted in a skull base fracture and fracture in the right femur. The patient received conservative care at the neurosurgical unit and was discharged in good condition. Afterward, the patient was referred to the orthopedic unit, where he underwent a femur fixation procedure using epidural anesthesia. The procedure was completed without any remarkable events.

Two days after, the patient developed a severe headache and disturbed level of consciousness; Glasgow Coma Scale (GCS) scored 11/15 (E3, V4, M4), with vomiting and irritability. Computed tomography (CT) of the cranium revealed a huge intracranial aerocele, including lateral, third, and fourth ventricles extending to the cervical subarachnoid spaces [Figure 1]. Under general anesthesia, 2 cm anterior to the coronal suture, and 3 cm off-midline (Kosher's point), a twist drill burr-hole was made to evacuate the air, followed by an under-water sealed external ventricular drain with repositioning of the head to mobilize the entrapped air

further. The 3-h postoperative CT scan [Figure 2] showed progressive filling of the fourth ventricle, cisterns Magna, and the upper cervical subarachnoid spaces. A second CT scan [Figure 3] 8-h postoperation was done and it showed the CSF filled the third and lateral ventricle. Prophylactic antibiotics, including 1 g of a third-generation cephalosporins twice daily, were administered during hospitalization.

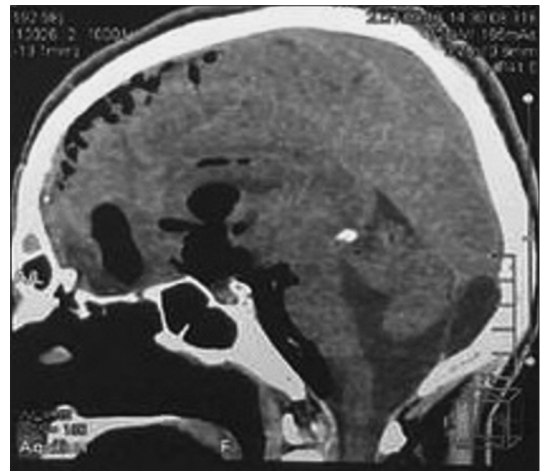
The patient's symptoms improved eventually as the follow-up CT scans confirmed the gradual resolution of the PNC, and the headache was relieved, while GCS scored 15.

### DISCUSSION

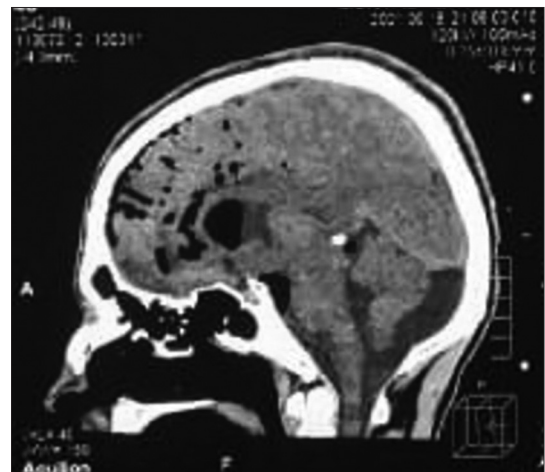
The most frequent cause of PNC is trauma, mainly basal skull fractures. Other causes include tumors, infections such as



**Figure 1:** Computed tomography scan of the head (axial view) reveals a large collection of intracranial air in all the cerebral ventricular system.



**Figure 2:** Computed tomography scan of the head (sagittal view), 3-h postoperation shows reduced pneumocephalus intracranially.



**Figure 3:** Cranial computed tomography scan (sagittal view), 8-h postoperation shows subsequent reduction of the pneumocephalus.

meningitis and abscess, CSF fistula, nitrous oxide anesthesia, and open brain surgeries. Meanwhile, the causes of PNC originating from the spine include trauma, tumor, and spine infection, and rarely, spinal surgeries and dural tears induced by spinal operations such as lumbar puncture and epidural injections are among the causes.<sup>[20]</sup> On the other hand, intraventricular PNC is a rare type of PNC that is usually reported after CSF shunt procedures in the form of small volumes of air, and they are often a self-limiting condition that does not require intervention and resolves at a rate of 25% per week.<sup>[11]</sup> Tension intraventricular air is a rare yet, life-threatening clinical complication. This report presents a case of a large-volume tension PNC involving all the ventricular systems following an epidural anesthesia procedure.

Epidural anesthesia is generally considered a safe and easy-to-perform procedure with a low prevalence of complications. The method is similar to a lumbar puncture, except that the needle is fixed before the dura is punctured.<sup>[6]</sup> There are two techniques to locate the epidural space, the loss-of-resistance to air (LORA) and the loss-of-resistance to saline (LORS).<sup>[7]</sup> Although the method of choice remains controversial, some papers reported a tendency toward using saline.<sup>[4,18]</sup> The anesthesiologists in our case utilized the LORA technique to locate the epidural space; the procedure was completed uneventfully.

Possible complications of the LORA technique are dural puncture which could be with or without postdural puncture headache, PNC, spinal cord and nerve root compression, subcutaneous emphysema, and air embolism.<sup>[14]</sup> A study done on 3730 patients who received epidural anesthesia for acute or chronic pain revealed that the incidence of headache after inadvertent dural penetration while using the LORA technique was significantly higher than while using the LORS.<sup>[1]</sup> Moreover, the clinical picture of tension PNC is similar to that of increased intracranial pressure, such as headaches with vomiting, deterioration of consciousness, seizures, and memory confusion.<sup>[11]</sup> Similarly, our patient presented with severe headache, an impaired level of consciousness, and vomiting 2 days after undergoing epidural anesthesia for a femur fixation procedure.

There were multiple cases in the literature reporting PNC after epidural procedures in different parts of the brain, including the ventricles.<sup>[7,9,15,20]</sup> In most of these cases, oxygen therapy is the treatment of choice, where the patient receives 100% of oxygen through a face mask to help resit nitrogen and reduce intracranial air volume.<sup>[15]</sup> However, in another case,<sup>[9]</sup> the patient had an extensive collection of intracranial air and decreased consciousness, which implied the surgical approach. An additional case reported an extensive PNC after a diagnostic lumbar puncture and a recent history of skull fractures; the patient was urgently treated with saline

infusion through two frontal burr-holes.<sup>[12]</sup> Similarly, in our case, the brain CT scans of the patient showed large volumes of air filling the cerebral ventricular system and compressing the cerebellum, in addition to a disturbed level of consciousness. Therefore, urgent surgery was done to evacuate the air.

Two theories describe air's pathophysiology within the skull.<sup>[13]</sup> The first is "the inverted soda bottle mechanism," which describes a decrease in the intracranial pressure caused by a continuous CSF leakage that results in air being drawn in by an existing dural defect, through which the pressure returns to its normal level. The second theory is "the ball valve mechanism," which describes air being forced into the cranium through a dural defect during pressure-increasing moments such as coughing or nose blowing.<sup>[9,19]</sup>

We assume that our case falls within the second theory. The ball valve mechanism was noted during the LORA procedure since neither CSF leakage nor CSF flashback. A previous paper suggested that in the absence of visible evidence of dural taps, such as no CSF flashback, the air enters the head either through an unidentified dural puncture or a dural defect in the lumbar area and subsequent arachnoid tear.<sup>[15]</sup> It is said that using saline instead of air in the loss of resistance technique will prevent air injection into the subarachnoid space.<sup>[1]</sup>

In summary, this case report describes a rare yet severe complication of PNC, possibly due to epidural anesthesia or a basal skull fracture. An immediate procedure was done to evacuate the air from the brain since it had a compressive effect on the cerebellum and caused neurological deterioration. Cases of tension PNC in the literature are scarce; only a few have been reported after epidural anesthesia, and fewer were of this extensive size.

## CONCLUSION

Extensive tension PNC can occur after traumatic brain injury, particularly after epidural anesthesia. These cases should gain high focus because they may have different management strategies from simple PNC cases.

## Declaration of patient consent

Patient's consent not required as patient's identity is not disclosed or compromised.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Aida S, Taga K, Yamakura T, Endoh H, Shimoji K. Headache after attempted epidural block: The role of intrathecal air. *Anesthesiology* 1998;88:76-81.
2. Almubarak AO, Fakhroo F, Alhuthayl MR, Kanaan I, Aldahash H. Tension pneumoventricle secondary to cutaneous-ventricular fistula: Case report and literature review. *World Neurosurg* 2020;142:155-8.
3. Armocida D, Pesce A, Frati A, Miscusi M, Paglia F, Raco A. Pneumoventricle of unknown origin: A personal experience and literature review of a clinical enigma. *World Neurosurg* 2019;122:661-4.
4. Cowan CM, Moore EW. A survey of epidural technique and accidental dural puncture rates among obstetric anaesthetists. *Int J Obstet Anesth* 2001;10:11-6.
5. Dabdoub CB, Salas G, Silveira ED, Dabdoub CF. Review of the management of pneumocephalus. *Surg Neurol Int* 2015;6:155.
6. Dahlgren N, Törnebrandt K. Neurological complications after anaesthesia. A follow-up of 18,000 spinal and epidural anaesthetics performed over three years. *Acta Anaesthesiol Scand* 1995;39:872-80.
7. Figueira H, Guimaraes J, Sousa AL, Regalado AM. Pneumocephalus following unidentified dural puncture: A case report with an unusual neurological presentation. *Pain Physician* 2017;20:E329-34.
8. Gonçalves MB, Nunes CF, Melo JO Jr., Guimarães RD, Klescoski J Jr., Landeiro JA. Tension pneumoventricle after resection of a fourth ventricle choroid plexus papilloma: An unusual postoperative complication. *Surg Neurol Int* 2012;3:116.
9. Gorissen Z, Hakvoort K, van den Boogaart M, Klinkenberg S, Schijns O. Pneumocephalus: A rare and life-threatening, but reversible, complication after penetrating lumbar injury. *Acta Neurochir (Wien)* 2019;161:361-5.
10. Hsieh XX, Hsieh SW, Lu CH, Wu ZF, Ju DT, Huh B, *et al.* A rare case of pneumocephalus and pneumorrhachis after epidural anesthesia. *Acta Anaesthesiol Taiwan* 2015;53:47-9.
11. Krishnan SS, Manuel A, Vasudevan MC. Delayed pneumoventricle following endonasal cerebrospinal fluid rhinorrhea repair with thecoperitoneal shunt. *Asian J Neurosurg* 2019;14:325-8.
12. Lee SH, Koh JS, Bang JS, Kim MC. Extensive tension pneumocephalus caused by spinal tapping in a patient with basal skull fracture and pneumothorax. *J Korean Neurosurg Soc* 2009;45:318-21.
13. 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.
14. McMurtrie R Jr., Jan R. Subarachnoid pneumocephalus: A rare complication of epidural catheter placement. *J Clin Anesth* 2002;14:539-42.
15. Nafiu OO, Urquhart JC. Pneumocephalus with headache complicating labour epidural analgesia: Should we still be using air? *Int J Obstet Anesth* 2006;15:237-9.
16. Tsai JC, Cheng KY, Tsai ST, Tsai MJ. Tension pneumoventricle and cerebrospinal fluid rhinorrhea. *QJM* 2017;110:39-40.
17. Tuğcu B, Tanriverdi O, Günaldi Ö, Baydin S, Postalci LŞ, Akdemir H. Delayed intraventricular tension pneumocephalus due to scalp-ventricle fistula: A very rare complication of shunt surgery. *Turk Neurosurg* 2009;19:276-80.
18. Wantman A, Hancox N, Howell PR. Techniques for identifying the epidural space: A survey of practice amongst anaesthetists in the UK. *Anaesthesia* 2006;61:370-5.
19. Young M, Putty M, Schaible K. Spontaneous intraventricular tension pneumocephalus: Case report and review of the literature. *World Neurosurg* 2018;114:317-22.
20. Yun JH, Kim YJ, Yoo DS, Ko JH. Diffuse pneumocephalus: A rare complication of spinal surgery. *J Korean Neurosurg Soc* 2010;48:288-90.

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