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Case Report

# Diffuse Pneumocephalus : A Rare Complication of Spinal Surgery

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The common etiologies of pneumocephalus, presence of air in the intracranial cavity, are trauma and cranial surgery. Pneumocephalus after spinal surgery is an unusual postoperative complication. We report the case of a male 59-year-old man who developed a pneumacephalus after posterior lumbar surgery for spinal stenosis. Intraoperatively, a cerebrospinal fluid leak following a dural tear was noted and immediately repaired. The next day, the patient complained of headache and dizziness. Head and lumbar computed tomography scans revealed significant air in the frontal region, several cisterns, intraventricle, and extra-dural area in the spine canal. Symptoms were spontaneously resolved within 2 weeks with conservative management.

**KEY WORDS :** Pneumocephalus · Spinal surgery · Dura tearing

## INTRODUCTION

Pneumocephalus is defined as the presence of intracranial gas[1]. It usually occurs when fractures of temporal bone air cells or paranasal sinuses tear the adjacent dura[6,8]. Other rare causes of pneumocephalus include traumatic or iatrogenic spinal dura tear[11,13,16,17]. Due to recent advances in instrumentation of spinal surgery, dural tears are inevitable and surgeons are faced with increasing numbers of cerebrospinal fluid (CSF) leaks. Tears in the dural sac and CSF leakage during post spinal surgery may lead to post-operative complications, such as meningitis, arachnoiditis, epidural abscess, delay of wound healing, dural-cutaneous fistula, and pneumocephalus[4]. We report a case of symptomatic pneumocephalus after lumbar spinal surgery. With this case report and brief literature review, we hope to make spinal surgeons more aware of pneumocephalus as a potential cause of headache and dizziness following spinal operation.

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## CASE REPORT

### History and Examination

A 59-year-old man presented with a tingling sensation and pain in both lower extremities of 6-months' duration. At admission, he complained of slight motor weakness of right foot. There was no significant medical history of or any recent history of trauma. Neurological examination revealed decreased motor strength in ankle dorsiflexion (4/5) on the right. Paresthesia and hypesthesia were present in both the L5 and S1 dermatomes. Both ankle reflexes were diminished and gait was unsteady due to pain and weakness in the leg. Neurologic claudication was precipitated by walking about 50 meters and relieved by a change in posture to squatting or to sitting. The patient denied any bowel or bladder dysfunction. Magnetic resonance (MR) imaging demonstrated severe spinal canal narrowing caused by hypertrophy of the facets and the ligament flavum with central protrusion of the disc at the L4-5 and L5-S1 levels. Unsuccessful nonoperative treatments at a regional hospital for 2-months led him to the decision to undergo surgery.

### Operations

The dissection and retraction of paraspinal muscles were completed by a posterior midline approach. The following

procedures were performed : an L-4 subtotal laminectomy, an L-5 total laminectomy, and a pedicle screw fixation. During the procedures, the incidental finding of a durotomy at the shoulder of the right L5 nerve root was discovered and repaired with fine silk sutures and fibrin glue, taking only a few minutes of time. A valsalve test was performed to confirm that there was no leak of the CSF. In addition, a rod insertion and posterolateral fusion were performed.

### Postoperative Course

On the first postoperative day, the patient began to complain of headache and dizziness. There was no CSF leakage from the wound. The following conservative management as applied : medication, injection and hydration. On the second postoperative day, the patient demonstrated psychological depression resulting from a progressive headache. Head computed tomography (CT) scan was performed and it revealed diffuse pneumocephalus involving, both sylvian and basal cisterns, frontal subdural area, and frontal horn of the lateral ventricle (Fig. 1). The spine CT scan, which was performed due to the possibility of dural injury related to misplacement of a screw, showed a small amount of extradural air without misplacement of the instruments (Fig. 2). The patient was managed conservatively with bed rest, hydration, and close monitoring. His symptoms were gradually improved and he was discharged with no neurological deficits after 2 weeks. Plain radiograph obtained 10 days after surgery showed that the placement screws were in good positions (Fig. 3). Due to his complete clinical recovery, a follow up CT was not performed.

## DISCUSSION

The term "pneumocephalus" is described as the presence of air in the intracranial cavity[13]. The air can be localized in subdural, subarachnoid, epidural, intraventricular, and intraparenchymal spaces[7,13,14]. The most frequent cause of pneumocephalus is trauma, especially fracture at the base of the skull[6,8]. Other intracranial causes of pneumocephalus include tumors, infections (meningitis and abscess), CSF fistula, N2O anesthesia, and cranial surgery[5,7,8,14,18]. Spinal causes of pneumocephalus include spinal trauma, tumor, infection, spinal procedures, and dural injury during spinal operation[1,3,10,11,13,16,17]. In review of the literature, there were 2 reports of symptomatic pneumocephalus secondary to iatrogenic dura tear and CSF leakage during spinal surgery[13,16]. One was a case of lumbar disc herniation with symptomatic tension pneumocephalus, due to iatrogenic CSF leak following surgical intervention and drainage with a vacuum suction device[16]. The other was a case of dural injury related to mispla-

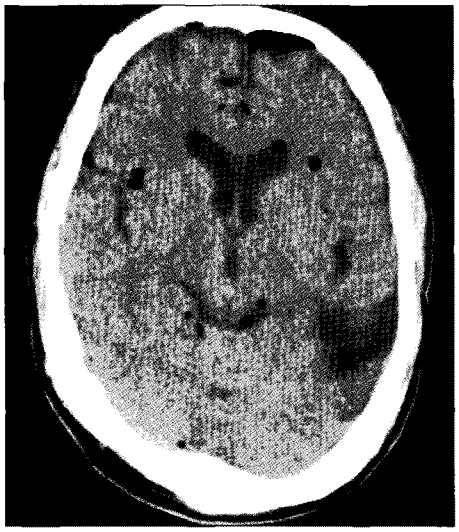

**Fig. 1.** Postoperative head computed tomography scan showing diffuse pneumocephalus.

**Fig. 2.** Postoperative lumbar computed tomography scan demonstrates air at the L-5 level.

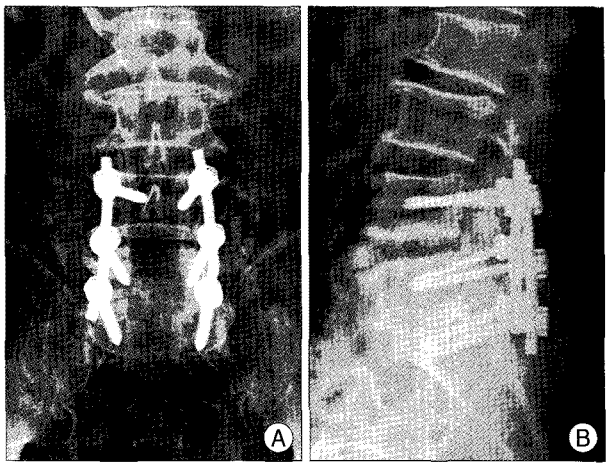


**Fig. 3.** Plain anteroposterior radiograph (A) and lateral (B) obtained 1 week post surgery.

cement of a screw for treatment of thoracolumbar scoliosis[13].

Signs and symptoms of pneumocephalus are often vague and nonspecific. A patient may complain of a headache, nausea and vomiting, dizziness, lethargy, an altered state of consciousness, and the triad of meningism[12]. These nonspecific symptoms can be misleading and are often considered to be insignificant following general anesthesia, as we did in this case. Pneumocephalus is diagnosed using simple X-ray, head CT scan, and MR imaging[6]. However, the diagnosis of pneumocephalus is not high on the diagnostic list when there is only a small amount of air. CT scan is a highly sensitive and specific diagnostic tool and is cost-effective in the diagnosis of this condition[12]. CT scan can detect even 0.5 cc of air in the intracranial compartment[12].

In this case, head CT scan showed a small amount of air in the frontal horn of the left lateral ventricle. It is noteworthy that air can enter the 4th ventricle via the foramens of Magendie and Lushcha, even though these are small openings and the subarachnoid space round being larger.

The pathogenesis of pneumocephalus have been suggested as the following 4 hypotheses[2,6,9,14,15]. First, it is the inverted bottle mechanism that promotes the hypothesis that continuous leakage of CSF causes negative intracranial pressure within subarachnoid space and negative pressure substitutes air for lost CSF. This substitution ends by balancing the pressure difference. Second is the ball valve mechanism. That is, air enters the intracranial cavity through a defect whenever extracranial pressure exceeds intracranial pressure (e.g., from the paranasal sinuses during coughing, sneezing, swallowing). Third, a role is played by nitrous oxide (N2O) anesthesia. Although completely restricted to the intraoperative period, N2O will diffuse into an air-filled cavity 34-times faster than nitrogen diffuses out. Thus, the volume and pressure of the contained pneumatocele rapidly increases (mimicking brain swelling). Finally, there is a gas-forming bacteria contributing to the development of pneumocephalus. The first mechanism may be applicable in our case.

To prevent pneumocephalus following unintended durotomy and CSF leakage during spinal surgery, we propose that the head should be kept in a head down position lower than the operative field and the dural sac should be soaked with irrigation saline. Moreover, it is important to maintain proper suction power during suture of the dura.

## CONCLUSION

Although very rare, a symptomatic pneumocephalus after lumbar spinal surgery might be perceived as insignificant. It is the goal of these authors to bring this issue to the attention of the spinal surgeon to remember of the issue of potential pneumocephalus, especially if headache, dizziness following durotomy, and CSF leakage during the spinal operation have occurred.

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## References

1. An BK, Hyun DK, Kim KC, Park CO, Ha YS : A case of anterior sacral meningocele with pneumocephalus and meningitis. **J Korean Neurosurg Soc 28** : 997-1000, 1999
2. Arbit E, Shah J, Bedford R, Carlon G : Tension pneumocephalus : treatment with controlled decompression via a closed water-seal drainage system. Case report. **J Neurosurg 74** : 139-142, 1991
3. Bilsky MH, Fraser JF : Complication avoidance in vertebral column spine tumors. **Neurosurg Clin N Am 17** : 317-329, 2006
4. Bosacco SJ, Gardner MJ, Guille JT : Evaluation and treatment of dural tears in lumbar spine surgery : a review. **Clin Orthop Relat Res** : 238-247, 2001
5. Gezici AR, Okay O, Ergün R, Dağlioğlu E, Ergüngör F : Rare intracranial manifestations of frontal osteomas. **Acta Neurochir (Wien) 146** : 393-396, 2004
6. Hong WJ, Yoo CJ, Park CW, Lee SG : Two cases of delayed tension pneumocephalus. **J Korean Neurosurg Soc 37** : 59-62, 2005
7. Jayaram S, Jadhav S, Rathod D, Tarvade S, Sornan A : Meningitis : an unusual cause of pneumocephalus. **J Assoc Physicians India 52** : 67-68, 2004
8. Lee JH, Kim BT, Cho SJ, Shin WH, Choi SK, Byun BJ : Tension pneumocephalus after shunting for hydrocephalus. -Case report-. **J Korean Neurosurg Soc 30** : 81-84, 2001
9. Lunsford LD, Maroon JC, Sheptak PE, Albin MS : Subdural tension pneumocephalus. Report of two cases. **J Neurosurg 50** : 525-527, 1979
10. McMurtrie R Jr, Jan R : Subarachnoid pneumocephalus : a rare complication of epidural catheter placement. **J Clin Anesth 14** : 539-542, 2002
11. O'Doherty DP, Ferris BB : Intracranial air after injury to the cervical spine : brief report. **J Bone Joint Surg Br 70** : 488, 1988
12. Osborn AG, Daines JH, Wing SD, Anderson RE : Intracranial air on computerized tomography. **J Neurosurg 48** : 355-359, 1978
13. Ozturk E, Kantarci M, Karaman K, Basekim CC, Kizilkaya E : Diffuse pneumocephalus associated with infratentorial and supratentorial hemorrhages as a complication of spinal surgery. **Acta Radiol 47** : 497-500, 2006
14. Seok JY, Kim HS, Bae HJ, Chung HR, Kim DH, Yoon YK : CT findings of diffuse pneumocephalus due to bacterial meningitis : a case report. **J Korean Radiol Soc 44** : 15-17, 2001
15. Sprague A, Poulgrain P : Tension pneumocephalus: a case report and literature review. **J Clin Neurosci 6** : 418-424, 1999
16. Turgut M, Akyüz O : Symptomatic tension pneumocephalus : an unusual post-operative complication of posterior spinal surgery. **J Clin Neurosci 14** : 666-668, 2007
17. Uemura K, Meguro K, Matsumura A : Pneumocephalus associated with fracture of thoracic spine : case report. **Br J Neurosurg 11** : 253-256, 1997
18. Walker FO, Vern BA : The mechanism of pneumocephalus formation in patients with CSF fistulas. **J Neurol Neurosurg Psychiatry 49** : 203-205, 1986