

# A Rare Complication of Lumbar Spine Surgery: Pneumocephalus

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## Abstract

**Purpose:** Pneumocephalus is an uncommon but serious complication of spinal surgery and its management and pathophysiology is not widely recognized. Incidence of symptomatic tension pneumocephalus secondary to posterior spinal arthrodesis is unknown. We describe a case of symptomatic tension pneumocephalus in the postoperative period of lumbar arthrodesis surgery, causes, risk factors, treatment and a review of the literature about this uncommon complication.

**Methods:** The clinical findings, radiological studies (Magnetic resonance imaging and CT scan), and treatment were presented.

**Results:** We report a rare case of a 41 year old woman with diagnosis of L3-L4, L4- L5 discopathy and left discal herniation L4-L5. A posterior spinal arthrodesis L3-L5, L3-L4 and L4-L5 discectomies and release of the left L5 root, was performed without apparent complications. 24 hours after surgery the patient developed generalized headache, neck stiffness, and dysarthria. MRI and CT scan revealed a huge pneumocephalus in the subarachnoid space, predominantly in the left frontal lobe without midline shift, which originates in the lumbar spinal canal. Treatment: The patient was treated conservatively, featuring 72 hours from progressive neurological improvement, up to clinical and radiological normalization after 7 days.

**Conclusions:** Pneumocephalus is a rare but potentially serious complication of spine surgery related in most cases with inadvertent dural tear during surgery. Most collections are small, behave benign, and respond to conservative therapy. In the majority of patients with pneumocephalus, a conservative approach consisting of bedrest, hyperhydration, analgesics, sedatives, and antiemetics is adequate, and symptoms resolve in a few weeks. In the present case with inadvertent CSF fistula, the vacuum drainage system predisposed the patient to pneumocephalus. A high degree of suspicion is needed to make the diagnosis, prompt treatment, and remedy of the source of air to prevent unwanted morbidity and mortality.

## Level of Evidence: IV

**Keywords:** Tension pneumocephalus; Postsurgical; Complication; Lumbar arthrodesis; Dural tear

## Introduction

Pneumocephalus, also known as intracerebral aerocele or pneumatocoele is defined as the presence of gas within any of the intracranial compartments (intraventricular, intraparenchymal, subarachnoid, subdural, and epidural) of the cranial vault [1]. The first case of pneumocephalus was described by Lecat in 1866, but the term pneumocephalus was first used to describe this unusual condition by Wolff in 1914 [2,3]. Pneumocephalus is usually associated with disruption of the skull after head and facial trauma and tumors of the skull base, following neurosurgery or otorhinolaryngological procedures. It is less common after spine surgery and although rare, can occur spontaneously [4]. Contributing factors for the development of pneumocephalus include the position of the head in surgery, duration of surgery, nitrous oxide anesthesia, hydrocephalus, intraoperative osmotherapy, hyperventilation, spinal anesthesia, and barotrauma, continuous cerebrospinal fluid (CSF) drainage via lumbar drain, epidural anesthesia, infections, and neoplasms. Clinical presentation includes headaches, nausea and vomiting, seizures, dizziness, and depressed neurological status that can cause death [4]. In clinical practice, it is paramount to differentiate simple from tension pneumocephalus. The latter refers to a collection under pressure compared to the outside atmospheric pressure, when, in most circumstances, a valve mechanism allows air to enter the skull but prevents it from escaping, thus creating differential pressure and a flow of adverse effects in the patient [1].

Incidence of pneumocephalus secondary to posterior spinal arthrodesis is unknown. There are only a few published reports of tension pneumocephalus after spinal operations [5].

## Case Report

A 41 year old woman otherwise healthy, who was operated on in 2007 for a herniated disc L4-L5 affecting left L5 root (lumbar discectomy L4-L5) came to our hospital in October 2009 with a history of left L3 and L4 radiculopathy since November 2008. An MRI exam showed left posterolateral protrusion of discs L3-L4 and L4-L5, reducing the area of the foramina of the left L3 and L4 roots. We performed a posterolateral interbody fusion procedure at levels L3-L5 with miniopen approach (percutaneous) in the left side and open procedure in the right (Figure 1). A vacuum suction drain was placed in the surgical area. We had no complications during the surgery. The patient recovered in the early postoperative period, but she developed a hypoesthesia and paresia in the right L5 metamere. Within 24 hours the patient developed a constant unremitting fronto-retro-orbital headache which intensified when in the upright position with photophobia, stiff neck and dysarthria without other associated neurological signs or symptoms.

Emergency CT scan (Figures 2-4) and magnetic resonance imaging

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**Received** October 28, 2015; **Accepted** November 20, 2015; **Published** November 23, 2015

**Citation:** Cesar AB, Pedro CG, Ulises HPM, Bernabe DR (2015) A Rare Complication of Lumbar Spine Surgery: Pneumocephalus. J Spine S6: 001. doi:10.4172/2165-7939.S6-001

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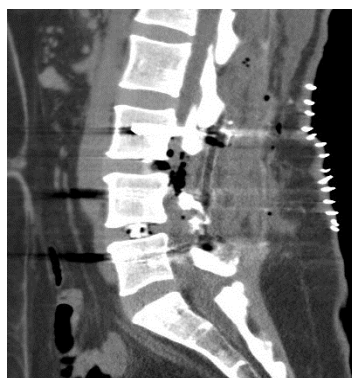
**Figure 1:** Anteroposterior and Lateral X Ray projection.



**Figure 2:** CT Scan. Brain Axial view.



**Figure 3:** CT Scan. L4 Axial view.



**Figure 4:** CT Scan. Lumbar Spine Sagittal view.

(MRI) of the spine and brain were performed (Figures 5-7), showing: Aerial images on bifrontal subarachnoid space (left predominantly) adjacent to the left middle cerebral artery, cisternal and ventricular

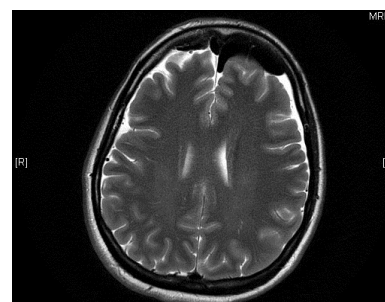
systems showed a normal size and morphology, without displacement of midline; no signs of ischemia or parenchymal hemorrhage were detected; circle of Willis vessels were permeable with normal caliber and morphology; air bubbles in the lumbar epidural space; postoperative changes in relation to fusion L3- L5; medialization of the L4 and L5 screws (only in the right side); no evidence of bruising or significant collections in lumbar area.

### CT Scan and MRI Conclusions

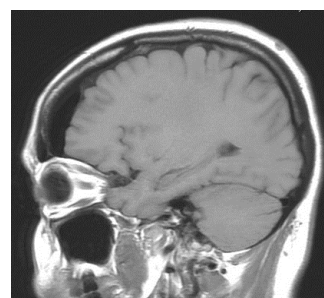
Bifrontal subarachnoid pneumocephalus mainly on the left side rising from lumbar spinal canal, medialization of the L4 and L5 screws (only in the right side). CT cisternography and MRI showed no anatomical defects that could have caused the pneumocephalus.

### Treatment

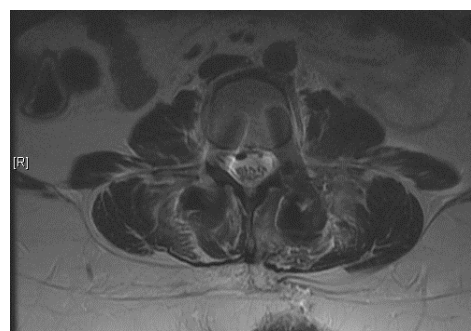
Bed rest (15° Trendelenburg position), analgesics, antiemetics and hyperhydration were the treatment given, with discontinuation of the suction drainage. Continuous neurological assessment was performed and CT every 24 hours remained unchanged during the first 48 hours. After that, she began a progressive clinical and radiological improvement until the complete disappearance of symptoms a week



**Figure 5:** MRI. Brain Axial T2 view.



**Figure 6:** MRI. Brain Sagittal T1 view.



**Figure 7:** MRI. L4 Axial T2 view.

later, with normalization of the images two days after that time. The patient remained in the ICU during the first 7 days.

Two weeks after recovery a second surgery was performed with revision of the right L4 and L5 screws, L4-L5 right hemilaminectomy, looking for signs of dural damage. We found a severe right L5 root intradural lesion without electrophysiological response. The postoperative period passed without incident, with progressive and complete recovery of sensory deficit and partial recovery of the L5 paresis after six months.

## Discussion

A large number of etiologies leading to pneumocephalus are classified and summarized in Table 1. Depending on local practice patterns and specialty, the common etiologies that a practitioner encounters will vary [1]. Craniotomies account for the most frequent cause and some amount of pneumocephalus is an inevitable result of a craniotomy [6]. Reasoner et al. reported that 66% of postcraniotomy CT scans demonstrated 5–10% of intracranial volume occupied by air on at least one axial CT section, and all postoperative scans demonstrated at least trace amounts of air [7].

Although typically asymptomatic in patients, pneumocephalus of sufficient volume has been implicated in postoperative lethargy; headaches, confusion, hemiparesis, and abducens nerve palsy [1-3]. Less frequently pneumocephalus can be presented as complication of endoscopic sinus surgery, microscopic skull base surgery, insertion of a ventriculo-peritoneal shunt.

Tension pneumocephalus has been described after drainage of subdural hematomas. Ishiwata et al. identified two signs in the CT which are very useful in the diagnosis of subdural tension pneumocephalus following surgery for chronic subdural hematoma: Subdural air separates and compresses the frontal lobes, creating a widened interhemispheric space between the tips of the frontal lobes; and the presence of multiple small air bubbles scattered through several cisterns ("air bubble sign"). These air bubbles enter the subarachnoid space through a tear in the arachnoid membrane caused by increased tension of air in the subdural space [8].

Fractures through air sinuses or the skull base, compound skull fractures with dural lacerations and congenital skull or tegmen tympani defects can all be associated with pneumocephalus [1,6].

Different types of tumors can cause erosion through the skull base or skull and cause this pathology [9-13]. Diagnostic procedures,

including lumbar puncture, ventriculostomy, and spinal anesthesia can introduce intrathecal air collections that may lead to significant pneumocephalus [14,15]. Barotrauma secondary to rapid changes of the surrounding air pressure such as air travel can turn otherwise benign cases of pneumocephalus into symptomatic cases of tension pneumocephalus that require urgent evaluation and treatment [16,17].

The rate of post-operative CSF fistula as an iatrogenic complication is reported to be as high as 5% in various spinal procedures [18]. However, cases complicated by pneumocephalus are rare [19].

Pneumocephalus is an uncommon but serious complication of spinal surgery and its management and pathophysiology is not widely recognized [20]. In the present case, pathophysiologically, the use of a drainage system after posterior spinal surgery allowed ingress of air into the subarachnoid space via a defect in the meningeal envelope. This was the only mechanism possible to explain the pneumocephalus. A ball-valve mechanism may allow air to enter but not exit the cranial/spinal cavity when the patient is in an upright position [1].

In clinical practice, pneumocephalus of spinal origin may be associated with fractures caused by spinal trauma, penetrating injury, tumors, infections, or iatrogenic causes including some diagnostic and therapeutic [20-23].

In the majority of patients with pneumocephalus, a conservative approach consisting of bedrest, hyperhydration, analgesics, sedatives, and antiemetics is adequate, and symptoms resolve in 1–3 weeks [1,6]. In the present case with inadvertent CSF fistula, the vacuum drainage system predisposed the patient to pneumocephalus. From a technical viewpoint, a watertight dural closure with different surgical methods using various tissue adhesives including cyanoacrylate, albumin, collagen, and glutaraldehyde glues, minimizes the risk of this complication.

## Conclusions

Pneumocephalus is a rare but potentially serious complication of spine surgery related in most cases to inadvertent dural tear during surgery. Most collections are small, behave benign, and respond to conservative therapy. In a great number of patients, it may behave like any space-occupying lesion; a high degree of suspicion is needed to make the diagnosis, prompt treatment, and remedy of the source of air to prevent unwanted morbidity and mortality. Efforts to understand and reduce complications in medicine, and spine surgery in particular have been hampered as a result of the lack of a meaningful and universally acceptable definition. The complex field of spine surgery has been a particularly challenging area for the development of a consensus to constructively describe these undesirable/unanticipated developments arising during or out of the delivery of health care.

## Acknowledgement

The authors have no source of funding for the completion of this article. We have no conflict of interest.

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1	<b>Skull defects</b>
	<b>Post-surgical:</b> Craniotomy, Transsphenoidal or endoscopic sinus surgery, Shunt insertion, Twist-drill drainage of chronic subdural hematomas.
	<b>Postraumatic:</b> Fracture through air sinus or skull base, Open fracture through cranial convexity with dural laceration.
	Congenital skull or tegmen tympani defects.
	Neoplasms causing tumor erosion through the skull or skull base
2	Infection with gas-producing organisms
3	Barotrauma.
4	<b>Post invasive procedures:</b> Lumbar puncture , Ventriculostomy, Spinal anesthesia
5	Complication of Spine Surgery.

**Table 1:** Etiologies of pneumocephalus.

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