Severe pneumocephalus after penetrating injury to the lumbar spine

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ABSTRACT

Introduction: Pneumocephalus is air or gas located in the intracranial cavity. Head trauma is the most common cause of pneumocephalus, with the majority of cases resulting from sinus and basilar skull fractures. A small number of case reports have been published describing pneumocephalus after cervical and thoracic penetrating injuries. To our knowledge, we report the first case of severe pneumocephalus in a patient with multiple penetrating stab wounds to the lumbar spine. Case Report: A healthy 21-year-old male presented to the trauma service with multiple stab wounds to the chest and lumbar spine after being assaulted. Computed tomography scans demonstrated severe pneumocephalus and pneumorrhachis. The patient had neurological deterioration and repeat head scans revealed worsening pneumocephalus. Myelography revealed a cerebrospinal fluid leak and thus warranted neurosurgical intervention to repair a dural tear. The patient made a full recovery without any neurological sequelae. Conclusion: Pneumocephalus caused by penetrating spinal trauma is exceedingly rare, especially to the lumbar spine and an extensive review revealed no cases in the literature. Our patient’s mechanism of trauma along with his clinical symptoms and radiographic images led to his timely diagnosis, avoidance of tension pneumocephalus and allowed for the most appropriate interventions for a full neurological recovery. The common etiologies, symptoms, diagnostic methods and treatment options relevant to this case will be reviewed.

Keywords: Pneumocephalus, Pneumorrhachis, Lumbar spine, Stab wound, Penetrating trauma

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INTRODUCTION

Traumatic pneumocephalus or air in the intracranial cavity, is most often seen after blunt trauma to the base of the skull or sinuses. There have been few published reports of traumatic pneumocephalus secondary to penetrating trauma to the upper spine, as well as reports of pneumocephalus following epidural procedures for anesthesia and lumbar puncture [1-6]. Pneumocephalus, regardless of etiology, can be devastating to the patient, with a clinical presentation ranging from mild cephalgia to coma, depending on the amount of mass effect on the brain from intracranial air. We report a unique presentation of massive pneumocephalus after penetrating knife injury to the lumbar spine with resulting spinal dural tear and subsequent cerebrospinal fluid (CSF) leak.
CASE REPORT

A previously healthy 21-year-old male was found in his apartment after an assault with an unknown weapon. Upon initial examination the patient was combative with a Glasgow Coma Scale of 13 and mild dyspnea. Respiratory rate, blood pressure, and heart rate were 29/min, 70/54 mmHg, and 154/min, respectively. There were four penetrating wounds to the left chest, two superficial wounds to the right chest, and four to the lumbar spine. There was no evidence of cranial bone trauma, including otorrhea, rhinorrhea or retroauricular ecchymosis.

Subcutaneous emphysema was palpated over the left chest, decreased breath sounds were noted and hypotension worsened, suggestive of tension pneumothorax. A left tube thoracostomy decompressed the pneumothorax and 700 ml of blood drained immediately. The abdominal examination was normal. Neurological examination was significant for increasing agitation and combativeness, requiring elective rapid sequence intubation. During the resuscitation in the emergency department, three units of intravenous crystalloid and two units of blood were administered to stabilize the patient’s hemodynamic status.

Computed tomography (CT) of the head was obtained, which revealed severe pneumocephalus, mostly subarachnoid, with no evidence of facial or basilar skull fractures or tension pneumocephalus (Figure 1). CT of the cervical spine revealed no bony fracture but intraspinal air (pneumorrhachis) was present. Thoracic CT revealed extensive subcutaneous emphysema, residual hemo-pneumothorax and pneumorrhachis. Abdominal and pelvic CT showed no signs of intraperitoneal trauma.

In the intensive care unit, all of the stab wounds were explored and none violated the abdominal cavity. A posterior stab wound extended to the level of the first lumbar vertebra and was irrigated and closed using sterile technique. There was a concern that these wounds may have caused a dural tear leading to the pneumocephalus and thus, intravenous antibiotics were begun. Due to ongoing thoracic hemorrhage, the patient was taken for exploratory thoracotomy for definitive repair of his injuries.

Postoperatively, the patient complained of severe headaches and profound confusion and repeat head CT showed worsening of the pneumocephalus. Neurosurgical consultation was obtained and a CT myelogram was performed. The myelogram revealed a dural tear with contrast extravasation at the level of the first lumbar vertebrae, (Figures 2A, B) consistent with CSF leak. The patient was taken to surgery and his injuries explored. At time of surgery, a 1x1 cm defect in the dura was encountered, as well as a small tear in the arachnoid, without evidence of spinal cord injury. The dura was repaired with a deep lumbar facial graft, which was sewn into place with a running 4-0 non-absorbable suture.

Repeat head CT scan seventy-two hours later revealed markedly reduced intracerebral air and the patient’s neurological status improved dramatically. The patient had a full recovery from all of his injuries and was discharged home without any neurological sequelae and was doing well at eighteen month follow-up.

DISCUSSION

Pneumocephalus caused by penetrating spinal trauma is rare, especially to the lumbar spine. There have been several reports of pneumocephalus since 1884, when Chiari reported an autopsy case in a patient with chronic ethmoid inflammation [7] and in 1927 when Cushing reported a case of pneumocephalus secondary to an eroding osteoma of the paranasal...
sinuses [8]. Review of the literature listed the numerous causes of pneumocephalus with traumatic fracture of the skull being most common at seventy-four percent [9]. Other causes include cranial or sinus neoplasms, infection and surgical intervention, namely cranial, sinus or thoracic surgery [9]. In current English literature, there have been three case reports of penetrating trauma to the cervical spine [1–3], and most recently, Teijirian reported a stab injury to the thoracic spine resulting in massive pneumocephalus that was treated conservatively [4]. To our knowledge, this is the first report of severe pneumocephalus after penetrating injury to the lumbar spine.

The leading theories on the mechanism of pneumocephalus are two-fold: a cerebral spinal fluid leak that causes the intracranial pressure to drop and is then compensated by an influx of air after respiration or cough; or a valve-like effect at a wound which allows atmospheric air to enter but not exit [2–3]. Our patient’s stab wound was deep enough to penetrate the dural and subarachnoid spaces, thus allowing cerebrospinal fluid leakage with entrance of air and subsequent entrapment within the spinal canal. The most serious complication, not seen in our patient is tension pneumocephalus. This occurs when progressive amounts of air accumulate in the intracranial cavity causing a significant mass effect and brain herniation with subsequent neurological compromise and death [10].

The clinical symptoms of pneumocephalus vary widely, from the asymptomatic to the completely obtunded, depending on how much mass effect the air is placing on the brain. Other concerns associated with penetrating injuries to the spine include persistent cerebrospinal fluid leak, cerebrospinal fluid fistula or meningitis. If there are no acute neurological complications of either pneumocephalus or pneumorrhachis, conservative management is warranted, including local wound care, antibiotic therapy, supplemental oxygen, and a slight Trendelenberg position. Surgical intervention should only be performed when there is neurological deterioration, persistent CSF leak or infection. In our case, severe cephalgia with confusion and a non-controlled cerebrospinal leak ensued, in which definitive repair was mandatory.

CONCLUSION

This case exhibits a rare and unusual cause of pneumocephalus after penetrating injury to the lumbar spine. Timely and accurate diagnosis based on clinical examination and radiographic imaging is essential for these uncommon injuries. Close observation and if warranted, surgical intervention is paramount in order to detect and correct neurological compromise and allow for the most appropriate management of these injuries.

Author Contributions
Michael A Valente – Conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Critical revision of the article, Final approval of the version to be published
Elizabeth A Bender – Conception and design, Critical revision of the article, Final approval of the version to be published

Guarantor
The corresponding author is the guarantor of submission.

Conflict of Interest
Authors declare no conflict of interest.

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