REVIEW ARTICLE

Posttraumatic delayed tension pneumocephalus: Rare case with review of literature

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ABSTRACT

Pneumocephalus is commonly seen after head and facial trauma, ear infections, and tumors of the skull base or neurosurgical interventions. In tension pneumocephalus, the continuous accumulation of intracranial air is thought to be caused by a "ball valve" mechanism. In turn, this may lead to a mass effect on the brain, with subsequent neurological deterioration and signs of herniation. Tension pneumocephalus is considered a life-threatening, neurosurgical emergency burr-hole evacuation was performed and he experienced a full recovery. However, more invasive surgery was needed to resolve the condition. Delayed tension pneumocephalus is extremely rare and considered a neurosurgical emergency. Pneumocephalus is a complication of head injury in 3.9–9.7% of the cases. The accumulation of intracranial air can be acute (<72 h) or delayed (≥72 h). When intracranial air causes intracranial hypertension and has a mass effect with neurological deterioration, it is called tension pneumocephalus. We represent a clinical case of a 30-year-old male patient with involved in a road traffic accident, complicated by tension pneumocephalus and cerebrospinal fluid rhinorrhea on 1 month after trauma and underwent urgent surgical intervention. Burr-hole placement in the right frontal region, evacuation of tension pneumocephalus. Tension pneumocephalus is a life-threatening neurosurgical emergency case, which needs to undergo immediate surgical intervention.

Key words: Cerebrospinal fluid leak, cerebrospinal fluid rhinorrhea, head injury, tension pneumocephalus

Introduction

Intracranial air entrapment (pneumocephalus) is commonly seen after head and facial trauma, ear infections, and tumors of the skull base or neurosurgical interventions. It has also been reported to occur spontaneously, but this is considered extremely rare, with less than a dozen reported cases in the literature. In tension pneumocephalus, the continuous accumulation of intracranial air is thought to be caused by a "ball valve" mechanism. In turn, this may lead to a mass effect on the brain, with subsequent neurological deterioration and signs of herniation. Tension pneumocephalus is considered a life-threatening, neurosurgical emergency burr-hole evacuation was performed and he experienced a full recovery. However, more invasive surgery was needed to resolve the condition.

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Case Report

A 30-year-old male was admitted to neurosurgery ward with a history of a head injury following road traffic accident. There was no history of loss of consciousness, vomiting, ear bleed, or seizures but the history of bleeding from nose present. On examination, his vital signs stable, he was conscious, well oriented to time, place, and person. His Glasgow Coma Scale (GCS) was 15/15. Pupils were 2 mm bilaterally and reacting to light. No any cranial nerves, motor, and sensory deficit detected. A plain computerized tomography (CT) was done which revealed bilateral frontal contusion with a fracture of bilateral frontal bone with involving the right frontal sinus with mild depression of posterior wall of the sinus with patchy pneumocephalus [Figure 1]. He was put on Antibiotic,

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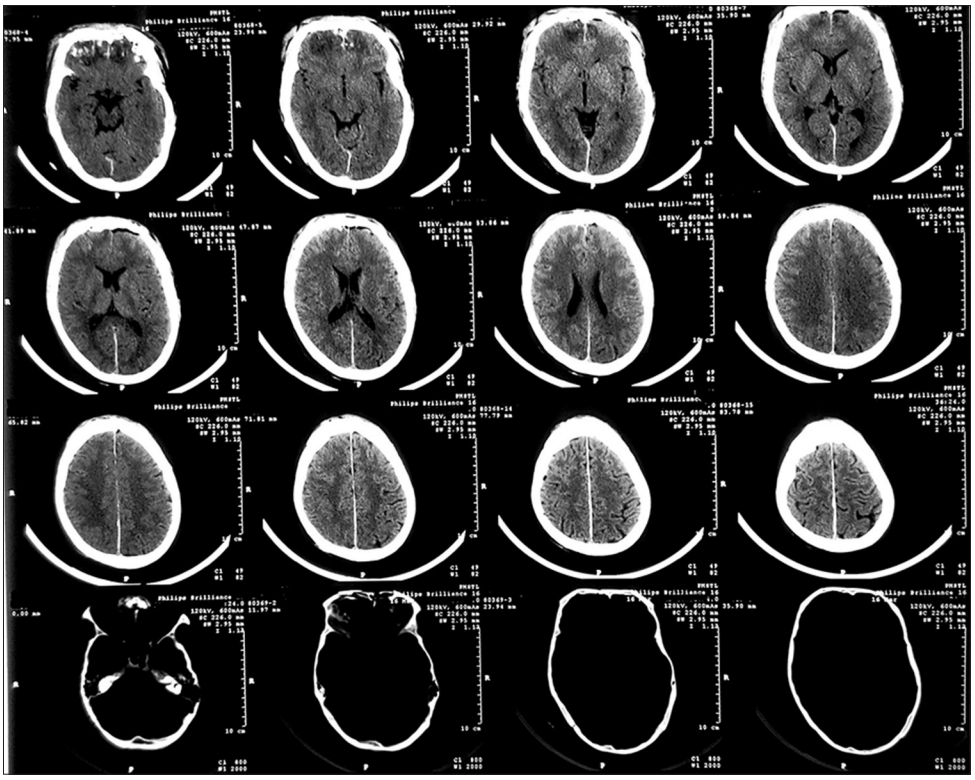

Figure 1: A plain computerized tomography was done which revealed bilateral frontal contusion with fracture of bilateral frontal bone with involving the right frontal sinus with mild depression of posterior wall of sinus with patchy pneumocephalus

anticonvulsant, and analgesics and patient was discharged 3rd of admission. At the time of discharge, the patient was intact without a focal neurological deficit and with no cerebrospinal fluid (CSF) rhinorrhea and GCS was 15/15. A month later, he complained of severe frontal headache with CSF rhinorrhea and progressively deteriorating neurologically then readmitted in neurosurgery ward and on admission his GCS dropped to 12, meningeal signs were found and he became bradypnea and repeat noncontrast CT (NCCT) head revealed tension intraparenchymal pneumatocele on the right frontal lobe with rounded or oval in configuration, measuring on average 3–4 cm in diameter with mass effect and communicating with bilateral lateral ventricles, basal cisterns, and subarachnoid spaces [Figure 2]. Under general anesthesia, a burr-hole was placed in the right frontal region and evacuation of tensed air subdural space was irrigated with normal saline and shifted to the neurosurgery Intensive Care Unit. Next day after the surgical treatment, he improved and became awake. Subdural drain was removed. A repeat NCCT head was done after 48 h which showed resorption of frontal pneumatocele with minimal subarachnoid and intraventricular air [Figure 3]. CSF rhinorrhea stopped.

The patient underwent a conservative treatment and observation. On the 5th day after the operation, an episode of hyperthermia up to 38°C developed. On the 10th day, nasal liquorrhea resumed. On the background of the therapy, a sustained clinical improvement was achieved. The patient refused to undergo proposed surgical intervention, aimed at dura defect closure in the posterior wall of the frontal sinus. And discharge on request and gone to any private multispecialty hospital and where watertight dura was closed and cranioplasty was performed. The postoperative period was uneventful, and CSF was without signs of inflammation. In 10 days after surgery, the patient was discharged. At his 6 month follow-up, he has no neurological deficit and no signs of rhinorrhea and meningitis.

Discussion

Pneumocephalus, also known as intracerebral aerocele or pneumatocele, is a collection of air in the cranial cavity.[1] It is a complication of head injury in 3.9–9.7% cases.[2] It also appears after supratentorial craniotomy in 100% of cases.[3] The accumulation of intracranial air can be acute (<72 h) or delayed (≥72 h).[4] As a rule, intracranial collection of air is benign and asymptomatic. When intracranial air causes intracranial hypertension and has a mass effect with neurological deterioration, it is called tension pneumocephalus. In the literature, 25 cases of tension pneumocephalus were described, 13 of them needed urgent surgery [Table 1]. In this article, we describe a rare case of delayed tension pneumocephalus who underwent urgent surgical treatment.

Intracranial pneumocephalus was first described in an autopsy report of a trauma patient in 1866.[5] Some years later,

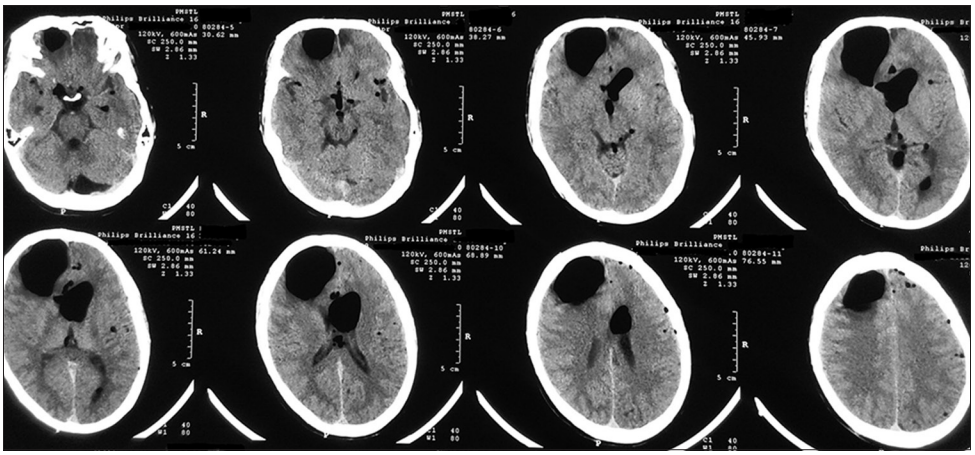

Figure 2: Repeat noncontrast computerized tomography head revealed tension intraparenchymal pneumatocele on right frontal lobe with rounded or oval in configuration, measuring on average 3–4 cm in diameter with mass effect and communicating with bilateral lateral ventricles, basal cisterns, and subarachnoid spaces

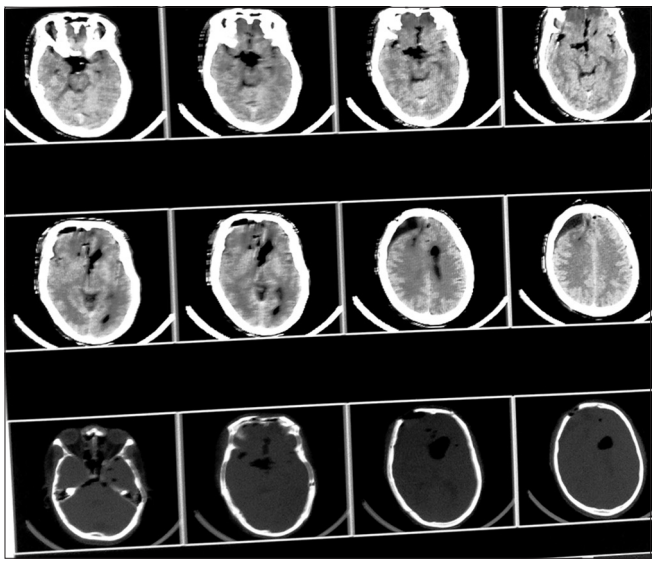

Figure 3: On postoperative noncontrast computerized tomography scans resorption of frontal pneumatocele with minimal subarachnoid and intraventricular air, there was a minimal residual pneumocephalus

Chiari reported a similar finding in an autopsy of a patient with chronic ethmoid sinusitis.[6] The usefulness of X-ray in diagnosing intracranial air was demonstrated by Luckett in 1913. The term "pneumocephalus" was invented by Wolff in 1914.[5] "Tension pneumocephalus" was first described in 1962 by Ectors, Kessler, and Stern.[7]

Mechanism of pneumocephalus development was described by two theories: (1) Dandy theory of "ball valve"[8] and (2) Horowitz "inverted-soda-bottle effect."[9] First one describes a unidirectional air movement from outside into the cranial cavity, which then gets trapped. The second theory tells that negative intracranial pressure (ICP) occurs as a result of excessive CSF loss due to any mechanism, for example, drainage in the physiological way during valsalva maneuver, or through the iatrogenic lumbar drain.

Pneumocephalus can be caused by trauma (basal skull fractures, paranasal sinuses fractures, and open cranial convexity fractures with dural laceration[10]), neurosurgical operations (twist-drill evacuation of chronic subdural hematomas,[11] ventriculoperitoneal shunting,[12] posterior fossa surgery in sitting[13] or lateral position,[14] cranial surgery in supine position,[3] ICP monitoring,[15] transsphenoidal or endoscopic sinus surgery, ENT operations (paranasal sinuses surgery; nasal septum resection; and nasal polypectomy), lumbar punctures,[16] barotraumas, tumors, central nervous system infections caused by gas-producing microorganisms, nitrous oxide, congenital skull and tegmen tympani defects, spinal anesthesia, positive pressure ventilation, hyperbaric oxygen therapy, spontaneous, and scuba diving.

Clinical presentation of tension pneumocephalus may include headache, generalized seizures, agitation, delirium, reflex abnormalities, and otherwise altered the level of consciousness, pupillary changes, and frontal lobe syndrome. Tension pneumocephalus localized in the posterior cranial fossa can cause clinical signs of brainstem dislocation,[17] including breathing rhythm changes and cardiac arrest. Some rare neurological symptoms of tension pneumocephalus were reported, such as marked weakness of both legs[18] and transient hemiplegia.[19]

CT is a golden standard for tension pneumocephalus diagnostics. A bilateral subdural hypoattenuation (Hounsfield coefficient – 1000) collections, causing compression and separation of frontal lobes (widened interhemispheric fissure), with separated frontal lobes tips on CT scans were described as "Mount Fuji sign" by Michel *et al*. as a pathognomonic sign of tension pneumocephalus.[20,21] But in my case, an intraparenchymal air-filled round cavity is seen in the right frontal lobe (tension frontal pneumatocele) pneumocephalus also seen in subdural, basal cisterns, and communicating with the frontal horn of bilateral lateral ventricle with a fracture of

Table 1: Review of literature of previously reported case of tension pneumocephalus

Author	Year	Number of case	Age/sex of patient	Description of patient	Management	Outcome
Satapathy and Dash	2000	1	10 years/male	Tension pneumocephalus developed in postoperative period after decompression of craniopharyngioma in supine position	Surgery	Good
Pillai *et al*.	2010	2	8 years/male	Traumatic tension pneumocephalus	Conservative	Good
			20 years/male	Traumatic tension pneumocephalus	Surgery	Good
Kon *et al*.	2003	1	46 years/male	Delayed tension pneumocephalus after 7 years of craniotomy	Surgery	Good
Sankhla *et al*.	2004	1	19 years/male	Delayed tension pneumocephalus after 6 months of shunt surgery	Surgery	Good
Kuncz *et al*.	2004	1	8 years/female	Traumatic prepontine tension pneumocephalus	Surgery	Good
Cho *et al*.	2004	2	Adult	Tension pneumocephalus which was developed after Transsphenoid surgery for pituitary adenoma and craniopharyngioma	Surgery	Good
Hong *et al*.	2005	2	64/male	Delayed tension pneumocephalus developed after ventriculoperitoneal shunt	Surgery	Good
			38 years/female	Delayed tension pneumocephalus developed after 12 years of trauma	Surgery	Good
Chandran *et al*.	2007	1	18 years/male	Delayed spontaneous tension pneumocephalus	Surgery	Good
Leong *et al*.	2008	2	42 years/male	Traumatic delayed tension pneumocephalus	Conservative	Good
			71 years/male	Traumatic early tension pneumocephalus	Conservative	Good
Lee *et al*.	2009	1	45 years/male	Delayed tension pneumocephalus caused by spinal tapping in a patient with basal skull fracture and pneumothorax	Surgery	Good
Shaikh *et al*.	2010	1	70 years/male	tension pneumocephalus after drainage of chronic subdural hematoma	Surgery	Good
Prüss *et al*.	2011	1	58 years/male	Tension pneumocephalus with diplegia after ethmoid sinus surgery	Surgery	Good

right frontal and ethmoid sinus. Plain X-rays can be also used for pneumocephalus diagnosis.[5]

Tension pneumocephalus treatment includes a complex of manipulations directed to removing of intracranial air mass effect, adequate skull base defects closure, and secondary posttraumatic meningitis prophylaxis. Initial treatment is usually conservative, including bed rest in an upright position, high concentration oxygen, avoidance of maneuvers that might increase intrasinus pressure (such as nose-blowing or valsalva maneuver), and antibiotics if there is evidence of meningism. Surgical treatment is indicated when there is recurrent pneumocephalus or signs of increasing ICP suggesting the development of tension pneumocephalus.[22] Surgical options include direct insertion of a subdural drain connected to underwater seal or, indirectly, with the use of a saline-primed camino bolt.[23]

Conclusion

Tension pneumocephalus is a life-threatening neurosurgical emergency case, which needs to undergo immediate surgical or conservative treatment. Even minor air collection in the cranial cavity has a risk of transformation into tension pneumocephalus in the case of valve mechanism development. Considering the existence of tension pneumocephalus mentioned cases and development in the late postoperative or/and posttraumatic period, these patients should be subject for long-term follow-up after discharge from the hospital.

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Conflicts of interest

There are no conflicts of interest.

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