Tension pneumocranium in childhood trauma

Hardeep Singh Gill, Arjan Bastiaan van As

Cape Town, South Africa

Background: **To report a case of fatal tension pneumocephalus in a 9-year-old boy following a severe motor vehicle accident.**

Methods: **A young boy with a serious closed head injury was resuscitated in the emergency room and underwent CT scan of the head and orbits.**

Results: **The CT-scan revealed a fracture of the orbital roof with extensive bilateral pneumocephalus.**

Conclusions: **A high index of suspicion for tension pneumocephalus is required in patients with severe head injuries presenting with periorbital swelling and perioccular trauma. A prompt CT scan and neurosurgical intervention are indicated.**

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peri-ocular trauma;
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Introduction

Although pneumocephalus occurs in less than 1% of head trauma cases, it is present in 8% of fractures involving the paranasal sinuses.[1] Pneumocranium or pneumocephalus denotes air present between the cranium and the dura matter and the term is often used to indicate extra-dural or sub-dural air. We describe a case of symptomatic tension pneumocranium, a life-threatening complication of severe head injuries. We present probably the first reported case of tension pneumocranium in Africa.

Author Affiliations: Trauma Unit, Department of Pediatric Surgery, Trauma Unit Red Cross War Memorial Children's Hospital, 6th floor, ICH Building, Red Cross War Memorial Children's Hospital, University of Cape Town, Rondebosch 7701, Cape Town, South Africa (Gill HS, van As AB)

Corresponding Author: Prof AB van As, MBChB, FCS(SA), MMed, MBA, PhD (UCT), Trauma Unit, Department of Pediatric Surgery, Trauma Unit Red Cross War Memorial Children's Hospital, 6th floor, ICH Building, Red Cross War Memorial Children's Hospital, University of Cape Town, Rondebosch 7701, Cape Town, South Africa (Tel: +27-21-6585012; Fax: +27-21-6856632; Email: Sebastian.vanas@uct.ac.za)

Case report

A 9-year-old boy involved in a high speed motor vehicle crash as a pedestrian was rushed by ambulance services to the trauma unit in our hospital within 1 hour with a cervical collar and an oxygen mask on. There was history of vomiting and aspiration during transit.

On arrival his Glasgow coma scale (GCS) was 6/15, the oxygen saturation was 68%, and the brachial blood pressure 80/35 mmHg and the pulse rate 127 beats per minute. He was resuscitated according to the Advance Pediatric Life Support (APLS) principles, intubated and connected to a ventilator after which there was good air entry bilaterally, and the oxygen saturation improved to 82%. Both pupils were pinpoint and sluggishly reacting to light. Intravenous Ringers lactate solution, normal saline and blood were administered through a peripheral venous line.

On examination he was found to have left periorbital oedema with a laceration to the upper eyelid. There were no signs of chest or abdominal injury.

A whole-body digital radiographic scan demonstrated a comminuted fracture of the lower third of the right femur and a right radial midshaft fracture. Urine dipstick revealed no blood.

Fine cuts on computed tomography (CT) scan of the brain without contrast (Fig.) revealed a left parietal skull fracture, a left sphenoidal wing and an orbital roof fracture. It also demonstrated an extensive bifrontal pneumocranium, with air visible in the right middle cranial fossa and orbits bilaterally. There was also a small left parietal subdural hematoma of mixed density, a small amount of bilateral occipital horn intraventricular blood and a left frontal contusion. The basal cisterns were patent and convexities of the sulcal markings were retained.

The patient was referred to and evaluated by the Department of Neurosurgery, however his level of consciousness progressively deteriorated. He developed a fixed dilated pupil on the left side with decorticate posturing. He also developed severe hypotension in spite of adequate fluid resuscitation and developed asystoly in spite of active resuscitation.

Consent for post-mortem examination was obtained. (1) Fractures: A skull vault fracture was found with an obliquely aligned linear fracture of the temporal bone

Fig. Bilateral frontal (white arrows) and right middle cranial (black arrow) pneumocephalus.

extending backwards to the occipital bone on the left and a base of skull fracture with an obliquely aligned fracture in the posterior cranial fossa on the left hand side. The fracture extended from the edge of the left petrous temporal bone going medially, involving the left cerebellar fossa and ending in the occipital ridge. Additionally, there was a fracture of the lower third of the right femur. (2) Brain findings: There was neither extradural and subdural hemorrhage nor subarachnoid haemorrhage. The brain was found to be swollen. The brain mass was 1390 g (Normal brain mass at 9 years is 1275 g). Cerebral contusion was present over the right occipital and frontal poles. Hydrocephalus was also found to be present. (3) Abdominal findings: There was a laceration of the spleen near its pedicle, but no free blood present in the abdomen.

Discussion

Tension pneumocranium occurs when air enters the cranium but cannot exit, most likely secondary to a one-way valve mechanism. The valve is usually a piece of dura which behaves like a flap. The result is increased intracranial pressure.[2]

The most common cause of pneumocephalus is head trauma that leads to fracture of the base of the cranium.[3-5] Besides, craniofacial operations, transsphenoidal surgery, ventriculoperitoneal shunt procedures, posterior fossa operations in sitting position, lumbar drainage, spinal anesthesia, lumbar punctures and operations for chronic subdural hematoma can also cause pneumocephaly.[6,7]

In our patient, tension pneumocephaly developed in the immediate period following orbital roof fracture. The thin orbital plate of the frontal bone may easily fracture. The dura over the orbital roof, paranasal sinuses and skull base is thin and tightly adherent to the bone, predisposing it to lacerations with associated fractures.

Intracranial air is distributed in anatomical spaces. In tension pneumocephaly, air most frequently occupies the subdural area.[3] However, air can also occupy the epidural, subarachnoid, intra-parenchymal and intraventricular areas. An epidural pneumocephalus occurs in the absence of a dural tear and is the least common. A subdural pneumocephalus is more common and is formed from a fracture involving the frontobasal region with an associated dural tear. A subarachnoid type requires a tear in the arachnoid, predisposing air to spread through the foramina of Lushka and Magendie to the ventricles. In our case, air exhibited the effect of a space occupying lesion in the subdural area in the anterior cranial fossa over the frontal area. When the brain and dura adhere to the fracture, the air does not spread beneath the meninges but penetrates the brain substance directly, resulting in intracerebral pneumocephalus.[1]

The Mount Fuji sign can be observed on CT-scans of the brain, in which bilateral subdural hypoattenuating collections cause compression and separation of the frontal lobes.[8,9] The collapsed frontal lobes and the widening of the interhemispheric space between the tips of the frontal lobes have the appearance of the silhouette of Mount Fuji — hence, the Mount Fuji sign. The Mount Fuji sign on CT scans of the brain is useful in discriminating tension pneumocephalus from non-tension pneumocephalus.[10] Tension pneumocephalus can be a neurosurgical emergency, unlike non-tension pneumocephalus.

The incidence of tension pneumocranium is rare but can be even more acutely devastating than meningitis because of the potential for cerebral herniation. Our patient probably had bilateral cerebral uncuse and a brainstem herniation which contributed to his rapidly deteriorating neurological and cardiovascular systems. Even pneumocranium that does not cause tension can be of consequence if it is of a significant volume. Secondary sequelae resulting from this complication can lead to seizures and cognitive impairment. If the dural repair permits air to get across, it is likely that bacteria may also use this conduit to access the intracranial cavity, resulting in meningitis.

The widespread availability of CT scanners provides the opportunity for more detailed diagnostic imaging. Because as little as 0.5 ml of air can be detected in cranial CT,[11] this modality can greatly aid in the early diagnosis of pneumocephalus and in the management of both blunt and penetrating orbital-cranial trauma.

The post-mortem findings also revealed a hydrocephalus. Traumatic hydrocephalus can occur in diffuse axonal injury, and in our case it is possible that air in the cranium could presumably also account for the hydrocephalus especially if it obstructed the foramina of Lushka and Magendie.

When the clinical and imaging findings are correctly identified, treatment consists of emergent decompression to alleviate pressure on the brain parenchyma. Treatment options for tension pneumocephalus include drilling of burr holes, craniotomy, needle aspiration, ventriculostomy placement, administration of 100% oxygen, and closure of dural defects.[10-12] Careful monitoring for clinical signs of deterioration as well as serial CT scanning of the brain is recommended.

In conclusion, this report stresses the importance of clinical vigilance in the event of severe head injuries with periocular involvement and supports the role of CT scan of the orbit and cranium as a first choice modality in the diagnosis of such conditions. Whereas simple pneumocephaly needs no treatment, tension pneumocephaly should promptly be evacuated. Evacuation of the air under high pressure can result in dramatic and fast recovery. As a surgical emergency, tension pneumocephalus can be successfully treated only by early diagnosis and treatment.

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