Tension pneumoventricle: A report of two cases

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Abstract

Pneumocephalus is often a complication of head trauma and cranial surgeries. Massive intraventricular pneumocephalus is an uncommon entity. We report the cases of two patients presenting same day with a clinical diagnosis of open head injury following separate road traffic accidents whose computed tomography (CT) brain images confirm skull base and vault fractures with massive pneumocephalus and tension pneumoventricles. CT scan remains invaluable in proper evaluation of head injury, and its complications for early and appropriate intervention toward reducing morbidity and mortality.

Key words: Computed tomography scan, pneumocephalus, tension pneumoventricle

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Introduction

Pneumocephalus refers to the presence of air within the cranial vault, and this may involve the extradural, subdural, subarachnoid, intracerebral, and intraventricular spaces.[1] It is commonly associated with head trauma and craniotomies but can also result from nontrauma-related causes. Air within the ventricular system of the brain is also known as pneumoventricle. Usually, small volume pockets of collections are encountered and are gradually reabsorbed into the circulation requiring only conservative management.[2] Tension pneumoventricle, which means the presence of air trapped under pressure within the ventricles, is a rare incident. We report two separate cases of posttraumatic tension pneumoventricles presenting on the same day with computed tomography (CT) scan investigations establishing the diagnoses.

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Case Reports

Case 1

A 48-year-old male, presented with 3 weeks history of headaches and fluid drip from the right nostril following involvement in a road traffic accident (RTA).

He was riding on a personal motorcycle without a crash helmet when another motorcycle rider crashed into him. He fell in the process, hitting his head on the tarred road.

He was initially treated and discharged from a peripheral clinic before he was referred to the Jos University Teaching Hospital as a result of increasingly severe headache and persistent nasal drip of clear fluid.

On the examination, he was found to be conscious with clear fluid dripping from the right nostril. He also had nonreactive right pupillary dilatation. He was diagnosed with mild open head injury based on his Glasgow Coma Scale (GCS) and sent for a cranial CT scan.

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The CT scan images [Figure 1] showed extensive pneumocephalus with right anterobasal, right frontoparietal, and left infratentorial pockets. Gaseous distention of the temporal horn of the left lateral ventricle was seen with mass effect on adjacent brain parenchyma. Both anterior ventricular horns were also gas distended with demonstrable air-cerebrospinal fluid (CSF) levels.

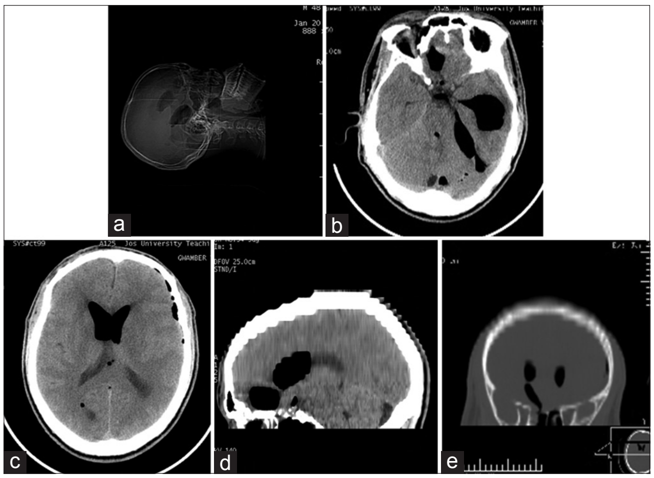

Figure 1: (a) Scanogram of Case 1 showing skull lucencies of pneumocephalus. (b) Axial computed tomography image showing pneumocephalus and left temporal horn tension pneumoventricles. (c) Pneumoventricle in lateral ventricles. (d) Sagittal reconstructed image of Case 1. (e) Bone window showing coronal section through the anterior ventricular horns and the cribriform plate, demonstrating skull base fracture and pneumocephalus/pneumoventricles in Case 1

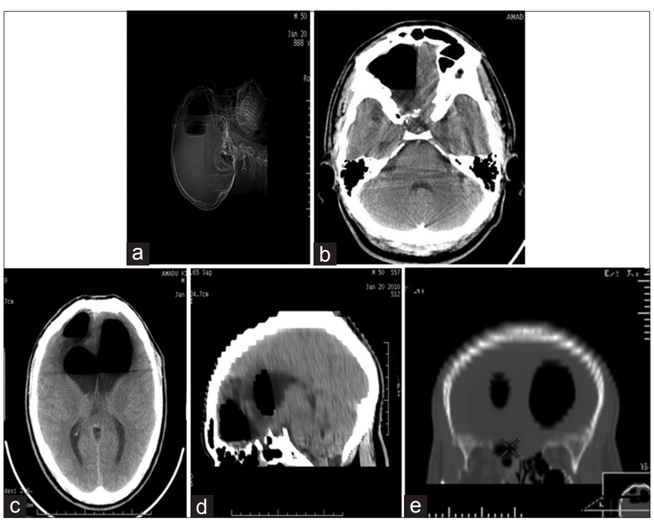

Figure 2: (a) Scanogram of Case 2 demonstrating skull lucencies with air-fluid levels in the supine position. (b) Axial computed tomography showing pneumocephalus over the right frontal basal skull. (c) Tension pneumoventricles in both anterior horns. (d) Sagittal reconstructed image of Case 2. (e) Bone window showing coronal section of the anterior horns of both lateral ventricles and skull base, demonstrating fracture site, pneumocephalus and pneumoventricles in Case 2

Bone window showed skull base fractures involving the cribriform plate, a right aspect of the body of the sphenoid, right frontal bone, and lateral wall of the right orbit.

He was nursed with bed elevated to 30° and had acetazolamide and analgesics. With no significant improvement after 72 h, he was referred to a neurosurgical center. An emergency burr hole was done forthwith, and ventriculostomy achieved by means of a cannula passed into the right lateral ventricle to let out the air before completion of the craniotomy and repair of the dural defect. He remarkably improved following surgery. Ventricular drain was removed on the 5th day. He was discharged on the 13th day postoperative.

Case 2

A 34-year-old male presented with a 3 days history of headaches and inappropriate talk following involvement in an RTA. He was a passenger in a commercial motor bike who was not wearing a crash helmet when they were knocked down by a car.

He was initially managed in a peripheral hospital from where he was referred to our center for further management.

On examination, he was found with GCS of 12, with clear fluid dripping from the left nostril. He was diagnosed with a moderate open head injury with CSF rhinorrhea. CT scan images [Figure 2] showed massive pneumocephalus with a large pocket in the right anterior cranial fossa demonstrating fluid level. Both anterior horns of the lateral ventricles are markedly distended with air and demonstrate air-CSF levels in the supine position.

Bone window showed depressed fractures of the right frontal bone. Fractures of the cribriform plate, planum sphenoidale, and lateral wall of the right orbit are also demonstrated.

He was admitted, nursed with the head of bed elevated and had acetazolamide and neurosedation with phenobarbitone. He was referred to a neurosurgical center after 2 days without improvement. Conservative management was continued at the referral center. He was maintained on acetazolamide and analgesics with antibacterial cover, and supplemental oxygen was administered. CSF rhinorrhea stopped after the fifth hospital day. He gradually recovered over a period of 2 weeks with sustained neurological progress. He requested for and was discharged on the 15th hospital day for financial reasons and has been lost to follow-up.

Discussion

Pneumocephalus is occasionally seen following craniofacial trauma and its incidence has been estimated between 0.5% and 1.0% of all head injuries.[3]

Nontraumatic factors causing pneumocephalus include intracranial tumors, intracranial infection and complications from craniotomies and spheno-ethmoidal surgeries.[4] It may be seen following spinal/epidural anesthesia, positive pressure ventilation, and administration of hyperbaric oxygen.[5]

Some authors advocated that two requirements are needed to the development of pneumocephalus: The presence of a CSF diversion system that causes a decrease in intracranial pressure, and the existence of a craniodural defect with or without an obvious CSF leak. Air traverses through this intra- or extra-cranial connection. A "valve mechanism" exists that does not allow air to escape, as the brain's soft tissue blocks the "valve" defect on the exhalation cycle.[6] There may or may not be a mass effect and increasing intracranial pressure.

The presence of intracranial air, therefore, indicates a form of CSF fistula. Air entering the intracranial space after meningeal breach flows "upstream" along the normal CSF pathways.[1] Intracerebral and intraventricular pneumocephalus result from tears in the dura and arachnoid layers.

Small volume collections of intracranial air of <2 ml are usually seen which are asymptomatic and resolve without treatment over about 2–3 weeks.[2] Larger volumes can be encountered with skull base fractures involving the air-containing sinuses and/or the cribriform plate where the dura is torn, and air is sucked in and trapped with respiratory efforts. Tension pneumocephalus will ensue in such scenario unless other extracranial communication occurs.[1] It is a serious complication progressing to a neurosurgical emergency when associated with clinical and neurological deterioration. Decompression into the ventricles rarely occurs.

Clinical signs of massive intracranial air include a headache, CSF rhinorrhea, pupillary changes, agitation, delirium and altered level of consciousness, focal neurological deficit, convulsion, frontal lobe syndrome, and cardiac arrest.[2] Episodes of bradycardia may also be seen with or without hypertension. A bruit hydro-aerique or "succussion splash" may be heard by the patient upon postural change which may also be audible with a stethoscope.[7]

A high index of suspicion and confirmation with neuroimaging are important in reducing mortality and morbidity. CT scan can play a vital role in determining the precise location of the gas collection, its relationship to the basal skull fracture site or air sinuses, the number and size of the air bubbles, and the degree of mass effect on the brain. Magnetic resonance imaging (MRI) can also demonstrate the presence of intracranial air, but its longer image acquisition time renders it less useful in the delirious patient compared to CT scan in the event of trauma.

Iatrogenic factors dominate nontrauma-related causes of intracranial accumulation of air. Lee *et al*.[8] had reported a patient who developed extensive tension pneumocephalus that required surgery after undergoing a diagnostic spinal tap. Nitrous oxide as an anesthetic agent can diffuse into air-filled spaces causing expansion of any trapped air loculi and has been linked to tension pneumoventricle[9] in the setting of surgery. Our two reported cases developed spontaneous symptomatic pneumocephalus and pneumoventricles following RTA. There was no account of any surgical intervention prior to their presentation.

The diagnosis of pneumocephalus can be made with a simple skull X-ray, which may show intracranial oval pockets of lucencies in orthogonal views depending on the mass of the gas collection with or without the linear lucencies indicative of skull fracture. This is invaluable in the absence of the availability of CT and/or MRI scan. CT scan is, however, the diagnostic modality of choice, with an ability to detect as little as 0.5 cm^3 of air.[10] Indeed, the reported incidence of posttraumatic pneumocephalus is approximately 10 times greater when using CT imaging as compared to plain films.[10] The scanogram in a CT scan (digital image of the skull) obviates the need for a skull X-ray and preludes the scrutiny of images in the serial rendition of axial sections of the cranium and its contents. Three-dimensional reconstruction and volume rendition are valuable tools to locate skull base and vault fractures. On MRI, all forms of intracranial air will appear completely dark (signal void) on all sequences. This can be distinguished from blood products by the antidependent position of air and layering atop hyperintense CSF on T2-weighted sequence as in the index cases of pneumoventricles.

Treatment is conservative in the majority of the instances. A craniotomy and ventriculostomy may be required to relieve pressure in cases of tension pneumocephalus or pneumoventricle. Surgical repair of the dural breach which could be open or endoscopic may be considered where associated CSF leak persists for more than a week. The presence of multiple pockets of air has a worse prognosis compared with solitary intracranial air bubble.[1] A mortality of about 10% has been reported.[7]

These cases also draw attention to the cons associated with the use of a motorcycle as a means of transportation in developing countries, especially in the setting where legislation on the compulsory use of accompanying crash helmets are either absent or not strictly adhered to.

It is interesting that the two cases above where both riding their motorbikes without crash helmets during the respective RTAs, both presenting later on the same date at the tertiary health facility with head injuries complicated with tension pneumoventricles.

CT scan was invaluable in appropriate diagnosis and decision-making on management options.

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Conflicts of interest
There are no conflicts of interest.

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