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Tension Pneumocephalus as a Complication of Intracranial Pressure Monitoring

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Abstract

We present the case of tension pneumocephalus resulting as a complication of intracranial pressure monitoring in a non trauma patient. Tension pneumocephalus is a neurosurgical emergency requiring early recognition and management. Our patient's CT head showed the typical Mount Fuji sign which prompted urgent neurosurgical decompression with favourable results. This manuscript also includes a description of the diagnosis and pathophysiology of pneumocephalus. This is the first published case to describe tension pneumocephalus resulting from intracranial pressure monitoring in a non trauma patient.

Keywords: Tension pneumocephalus; Mt Fuji sign; Intracranial pressure monitoring

Introduction

Pneumocephalus is a term used to describe the presence of intracranial air. Common causes include trauma, infection, cerebrospinal fluid (CSF) leak, and any fistula or conduit between the intracranial cavity and external air. Pneumocephalus has been reported to occur in all cases following supratentorial craniotomy [1]. Areas of extreme hypodensity (Hounsfield coefficient -1000) in the subdural space on computed tomography (CT) is characteristic of pneumocephalus. If the volume of pneumocephalus is sufficient enough to exert mass effect on the brain, it is termed tension pneumocephalus and considered a neurosurgical emergency requiring decompression before brain herniation and death result.

Intracranial pressure (ICP) monitoring is commonly performed and may be achieved with the placement of either subdural, extradural, intraparenchymalor intraventricular devices. Although a relatively safe procedure, complications may include infection, haemorrhage and malposition. We present a case of tension pneumocephalus as a complication of ICP monitoring.

Case Presentation

A 61 year-old gentleman was electively admitted for intracranial pressure monitoring. Five years prior a right-sided ventriculo-peritoneal shunt (STRATA II valve) had been inserted for post-traumatic delayed hydrocephalus. He had progressive worsening of headaches since shunt insertion, despite the shunt being set at the lowest possible setting of 0.5. The characteristics of his headaches were unclear but suggested shunt malfunction. The CT head showed dilated ventricles with no periventricular lucency (Figure 1). He thus presented for intracranial pressure monitoring.

Under general anaesthesia an intraparenchymal pressure monitor (Codman Micro sensor Basic Kit bolt) was inserted at Kocher's point on the right side via twist drill craniostomy. Opening pressure was measured at 10 mmHg and the patient awoke from anaesthesia unremarkably. The ICP readings were less than 10 mmHg throughout whilst the ICP monitor was *in situ*. Overnight the monitor and bolt became dislodged. The bolt and monitor were removed and the wound closed with sutures. Over the next hour the patient became increasingly restless and agitated, began vomiting and his GCS decreased from 15 to 12 (M6, E4, V2). A CT demonstrated classical tension pneumocephalus with Mt. Fuji sign and air within the cisterns ('air bubble sign') (Figure 2A and B). He underwent urgent decompression through bilateral frontal burr holes. He had an immediate and full recovery to his pre-operative state and was discharged two days later.

Discussion

Tension pneumocephalus results from the one-way movement and expansion of air into the subdural space. This one-way movement has been attributed to two possible mechanisms. The first, known as the 'inverted pop bottle' mechanism, was described by Lunsford et al in 1979 [2]. By

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Figure 1: Axial CT demonstrating adequate placement of ventriculoperitonel shunt and ventriculomegaly.

this mechanism, as CSF leaks, air is drawn into the cranium akin to air bubbles rising in an inverted soda bottle as fluid pours out. The second, known as the 'ball-valve' mechanism describes how once air is trapped intracranially it cannot escape through the channel whence it came. This was the most likely mechanism in our case, with the ICP monitor insertion site being the one way valve.

The Mount Fuji and air bubble signs are pathognomonic of tension pneumocephalus [3] and result from air pressure exerted on the brain leading to depression and separation of the frontal lobes, which may ultimately manifest as brain herniation and death. Tension pneumocephalus as a complication of intracranial pressure monitoring was first described by Vitali et al. [4] in a trauma patient who had a subdural cup catheter ICP monitor inserted. To the best of the authors knowledge, this is the first published case of tension pneumocephalus occurring in a patient electively admitted for ICP monitoring using an intraparenchymal pressure monitor. Our patient may have been at increased risk of air ingress given he had a VP shunt *in situ* which will have augmented any pressure gradient between the atmosphere and intracranial space. Indeed, tension pneumocephalus is recognised as a rare complication of VP shunt insertion surgery [5].

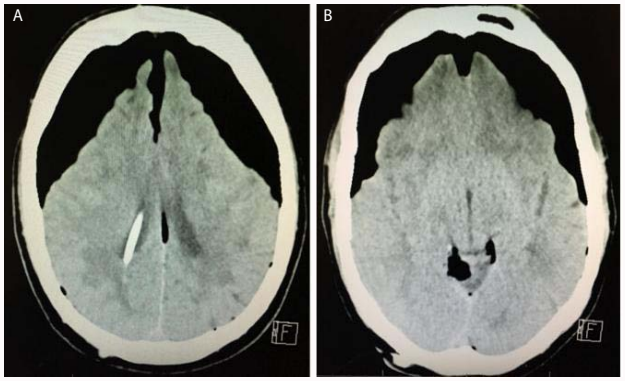

Figure 2: (A,B) Axial CT showing Mount Fuji sign and air in basal cisterns. Note seperation and depression of frontal lobes.

Conclusion

Intracranial pressure monitoring is commonly performed in both trauma and elective neurosurgical patients. This rare complication demonstrates upmost care must be employed when securing the monitor and during scalp closure to prevent this potentially fatal complication.

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