CASE REPORT

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Delayed Tension Pneumocephalus Caused by Ventriculoperitoneal Shunt

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The authors describe a rare case of tension pneumocephalus, caused by ventriculoperitoneal(V-P) shunting for communicating hydrocephalus. The patient had a history of a right frontal skull fracture and pneumocephalus after a traffic accident five months prior to the present presentation of gait disturbance and memory impairment. A CT scan showed hydrocephalus and a V-P shunt was put in place. On the fourth day after surgery, the mental status of the patient gradually deteriorated due to a tension pneumocephalus; this was treated by repairing a fistula in the frontal sinus and a dural defect. The patient's mental status improved and symptoms were completely recovered. We report a case of tension pneumocephalus following V-P shunt for hydrocephalus in a patient who sustained a right frontal skull fracture.

KEY WORDS : Skull fracture · Ventriculoperitoneal shunt · Pneumocephalus.

Introduction

The presence of air inside of the skull results from a connection between the atmosphere and the intracranial cavity[17]. Non-tension pneumocephalus is a common consequence of cranial surgery, and is a relatively benign complication that usually resolves spontaneously. However, tension pneumocephalus is rare and can mimic an expanding intracranial space-occupying lesion it may lead to rapid deterioration of the patient, thereby requiring prompt treatment[6-8]. In this study, we report a case of tension pneumocephalus following V-P shunt for hydrocephalus in a patient who sustained a right frontal skull fracture.

Case Report

A 47-year-old male was transferred to our department, from orthopedic surgery, for the treatment of normal pressure hydrocephalus. He had a history of trauma five months prior to his current treatment, and had been treated for an open fracture of the left ulna. At that time conservative treatment was carried out for a right frontal skull fracture with scanty pneumocephalus, subarachnoid and intraventricular hemorrhage (Fig. 1A, B). During the admission he had a gait disturbance and memory impairment. The computed tomography(CT) scanning revealed enlargement of the cerebral ventricles with periventricular low density images (Fig. 1C). A right V-P shunt was put in place; four days after the shunt was placed the patient suffered from severe headache and drowsy consciousness. An emergency CT scan showed a very large right frontal accumulation of air compressing the entire brain with an opened frontal sinus (Fig. 1D, E).

We found the site of connection between frontal sinus and pneumocephalus from three-dimentional CT scan. Bicoronal frontal craniotomy with extracranial exploration of the base of skull was performed to repair the dura mater and close the frontal sinus. During the operation, we found dura plugging at the inner table of the frontal sinus and the frontal sinus was opened. The frontal sinus was repaired with harvested fascia and oxidative cellulose and covered by frontal fascia. The dural defect was repaired with fascia, Lyo-plant and oxidative cellulose. Postoperatively, the patient improved and all the symptoms resolved. Follow-up CT scan revealed no more air inflow (Fig. 1F).

Discussion

Pneumocephalus is described as a presence of intracranial air and commonly occurs with head trauma, after neuro-

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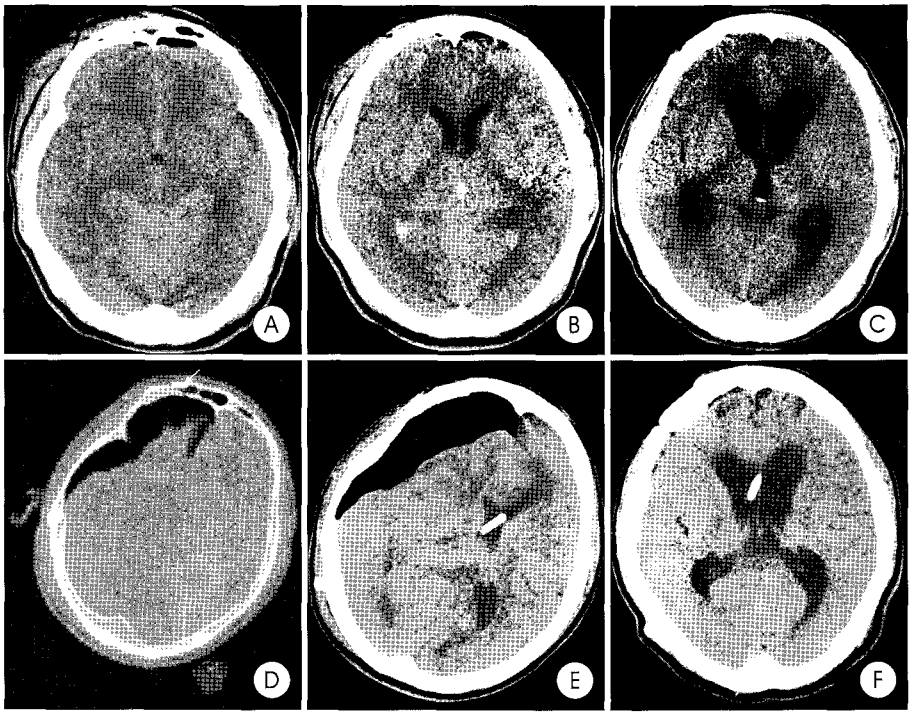

Fig. 1. Computed tomography(CT) showing pneumocephalus at both frontal areas and subarachnoidal and intraventricular hemorrhage after trauma. And right frontal skull fracture at the time of the initial injury is also seen (A, B). After five months, follow-up CT scan showing hydrocephalus with periventricular low density (C). A right V-P shunt was put in place and four days later the patient suffered from a severe headache and reduced consciousness. CT scan shows tension pneumocephalus and an open frontal sinus (D, E). After frontal sinus and dural defect repair, follow-up CT scan shows no more air inflow (F).

logical surgery with skull defects, in the presence of a brain abscess, bone erosion as a result of an intracranial tumor or with posterior fossa surgery in sitting position and N_2O anesthesia[1,2,8,12]. In most cases, pneumocephalus resolves with conservative treatment. However, many cases with a large tension pneumocephalus in the intracranial cavity, characterized by symptoms including headache, restlessness, hiccoughs, confusion, disorientation, anisocorea, hemiparesis, sign of meningeal irritation and neurological deterioration require surgical treatment[16,17]. Diagnosis of pneumocephalus or other postoperative complications requires use of simple X-ray, brain CT scan, brain magnetic resonance imaging for evaluation[4,7]. In this case, the brain CT scan showed subdural tension pneumocephalus at both frontal areas and an opening site at the frontal sinus. The pathogenesis of tension pneumocephalus is explained by the following two hypotheses. First, the "ballvalve" mechanism requires a pressure difference between the atmosphere and the intracranial space once air is forced in, its exit is prevented by the brain or meninges that seal off the leak site temporarily. Second, the "inverted bottle" mechanism is associated with a cerebrospinal fluid leak in which air replaces the lost fluid volume[6,8]. In our case, the mechanism of development of pneumocephalus was mainly based on two factors[5,6,10,13,15]. A reduction in the intracranial pressure, and the presence of a defect in the dura and skull that was caused by the previous trauma. A longstanding elevation in intracranial pressure, due to hydrocephalus, can remain asymptomatic as long as the defect is completely plugged by meningeal scarring. Significant lowering of intracranial pressure, following shunt placement, caused unplugging of the defect that resulted in the opening up of the fistula. The treatment is essentially that of acute intracranial hypertension, therapy or prophylaxis for meningitis, shunt management, and repair of the fistula[3,4,16]. For the treatment, complete repair of the opened frontal sinus including sinus packing with muscle and bone dust mixed with antibiotics, and covering with periosteum or galea stitched to the dura is very important to avoid subsequent sinus opening[7,9,11,15]. In our case, we urgently performed surgery for reconstruction of the injured sites, and elevation of shunt pressure using a programmable shunt system after surgery[14].

Conclusion

We present a rare case of delayed tension pneumocephalus after V-P shunt for post-traumatic hydrocephalus with skull fracture. Before performing the V-P shunt, we must be aware of the connection site between extracranial and intracranial cavity in such patients.

In addition, the three-dimentional CT scan is more accurate and useful to identify a sinus opening site. The use of a programmable shunt system is useful for adjusting pressure as it was in our case.

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