Postoperative Tension Pneumocephalus

—Report of 2 Cases—

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Summary: Two cases of tension pneumocephalus produced by iatrogenic causes are described. Dural tears were produced by a pin of a Mayfield head-holder in one case and by pansinectomy in the other case. In addition, both cases had procedures which induce low cerebrospinal fluid (CSF), such as a ventriculo-peritoneal shunt or lumbar punctures. For production of tension pneumocephalus in these cases, CSF diversionary procedures may play an important role in the accumulation of air in the intracranial space.

Key words: tension pneumocephalus—CT scan—intracranial air—pansinectomy—pin-type head-holder

Introduction

Tension pneumocephalus is defined as the accumulation of air or gas in the intracranial cavity either in the epidural, intracerebral, intraventricular or subarachnoid space. It occurs most commonly as a sequela of head trauma (Black et al, 1979; Briggs, 1982; Lunsford et al, 1979; Magnaes and Nornes, 1967; Wesley and McCord, 1976). However, other causes such as neoplasms (Briggs, 1974; Gotham et al, 1980; Markam, 1967), infections and intra- or extra-cranial surgery (Bouzarth et al, 1980; Bremer and Nguyen, 1982; Capanna, 1980; Davis et al, 1981; Effron et al, 1981; Findler et al, 1980; Pop et al, 1982) have also been reported. This report deals with two cases of symptomatic tension pneumocephalus induced by iatrogenic causes.

Case Report

Case 1:

A 12-year-old girl complained of a headache and vomiting at school and was sent home in April, 1982. A couple of hours later, she was found to be comatose and was transported to a nearby hospital. A computerized tomographic (CT) scan revealed a marked ventriculomegaly with a partially calcified suprasellar mass (Fig. 1). Emergency ventriculo-peritoneal (VP) shunting was performed and she regained consciousness. Subsequently, she was transported to the Department of Neurosurgery, Kurume University Hospital for further treatment of the suprasellar tumor.

On admission, she was fully alert and a right homonymous hemianopsia was noted. There were no apparent clinical manifestations, such as endocrinological deficiencies. A plain skull X ray demon-
Stratified a saucer like deformity of the sella turcica with suprasellar calcification. A CT scan demonstrated a suprasellar mass with calcification without ventriculomegaly. She underwent craniotomy with the diagnosis of craniopharyngioma on May 19, 1982. Under general anesthesia with GOF, she was placed in the supine position and her head was fixed in a Mayfield’s head-holder with three pins. With a right frontotemporal approach, total excision of the tumor was successfully performed. The immediate postoperative recovery seemed to go well and she regained her consciousness. However, 1 hour after the operation, she developed a convulsive seizure and became comatose with anisocoria. Repeated CT scanning revealed a large subdural pneumocephalus in the bifrontal region with marked compression of the brain parenchyma (Fig. 2). Careful inspection of the head revealed that a pin in the right frontal area of the head holder had penetrated the skull into the subdural space. This iatrogenic stab wound was closed by stitching the scalp without any measures to avoid intracranial air accumulation. Repeated CT scans taken 14 days after the operation revealed a hemorrhagic infarction in her right occipital lobe as a result of the tentorial herniation (Fig. 3). The patient remained in a vegetative state until her death, three years later.

**Fig. 1.** Case 1. Preoperative CT scan demonstrating a large calcified suprasellar mass with marked ventriculomegaly.

**Fig. 2.** CT scan shortly after the operation showing a large amount of subdural air in the bifrontal areas. There is considerable compression of the frontal horn.
Fig. 3. A repeat CT scan, fourteen days after the operation, revealed a hemorrhagic infarction in the right occipital area and subdural fluid collection in the right frontotemporal area.

Case 2:

A 55-year-old man complained of headache, double vision and ophthalmic pain for 6 months and was admitted to the Department of Otorhinolaryngology, Kurume University Hospital in May 1981. An otorhinolaryngological examination demonstrated no abnormalities in the nose, choana and epipharynx. A tomogram of the paranasal sinus revealed a cloudiness of the ethmoidal and sphenoidal sinus without definite bone destruction.

In June 1981, the patient underwent right pansinectomy under local anesthesia. During operation, bone destruction was observed at the posterior wall of the ethmoidal sinus and the dura was fibrous and thickened due to chronic inflammation. The postoperative course was uneventful and his complaints completely disappeared. Seven days after the operation, the patient suddenly developed a cerebrospinal fluid (CSF) rhinorrhea with nausea and headache. The neurological examination was normal except for nuchal rigidity which suggested a meningeal irritation. Inspection of the operative field revealed no abnormalities except for the edematous mucous membrane of the sphenoid sinus. A lumbar puncture showed an opening pressure of 35 mmH₂O and the CSF analysis demonstrated 807/3 of cells, 48 mg/dl glucose and 163 mg/dl protein. With the diagnosis of bacterial meningitis, antibiotics were administered. The CT scan showed a diffuse accumulation of air in the subarachnoid space, as well as in the

Fig. 4. Case 2. CT scan showing a large amount of air diffusely distributed in the cortical sulci, ventricles and cisterns. Note the small ventricles due to the compression of the air.
bilateral lateral ventricle (Fig. 4). On the following day the patient became lethargic and disoriented. He was transferred to the Department of Neurosurgery and an emergency craniotomy was performed under the diagnosis of tension pneumocephalus. When the dura mater was opened, the arachnoid membrane was extremely tense and discolored. Following incision of the arachnoid membrane, a large amount of subdural air was discharged and the subarachnoid space collapsed just like a deflating balloon. On detailed inspection of the frontal skull base, a dural defect at the planum sphenoidale was noted and dural plasty with a muscle piece and alfacianoacrylate was successfully performed.

The postoperative recovery was slow but essentially uneventful and the patient became neurologically intact 7 weeks after the craniotomy. He made a full recovery.

Discussion

In 1884, Chiari first reported a case with intracranial pneumocephalus, when he demonstrated a fistulous connection between the ethmoid air cells and the frontal lobe. The diagnosis of the pneumocephalus by roentgenography was first reported by Luckett (1913). Since then, the diagnostic importance of intracranial air on the X ray film has been stressed.

With the recent advance of CT scans, intracranial air is easily detected and the exact location, as well as the distribution, are also precisely defined. Since intracranial air in volumes as small as 0.5 ml, can be detected by the CT scan, the absence of air on the standard X ray does not necessarily rule out intracranial pneumocephalus (Osborn et al, 1978).

The most common cause of CSF rhinorrhea is a head injury. However, CSF rhinorrhea from other etiologies have also been well described. They include tumors, inflammations, infections and iatrogenic causes. Some iatrogenic causes are: complications of the burr hole operation for the chronic subdural hematoma, transsphenoidal surgery, paranasal sinus surgery and posterior fossa craniectomy (Table 1).

In case 1, the air apparently entered the subdural space through the stab wound in the frontal area as a complication of pin fixation with the Mayfield head-holder, and the presence of the VP shunt probably enhanced the accumulation of air (Pitts et al, 1975). This case is unique in the literature, except for a case report in which Pang (1982) described a similar experience.

Two mechanisms for air entrance into the intracranial cavity have been reported.

| TABLE 1 |
| Iatrogenic Causes of Tension Pneumocephalus |
| 5. Craniofacial surgery (Findler et al, 1980). |
| 8. Paranasal sinus surgery (Davis et al, 1981; Case 1). |
| 9. Perforation of carvaria by a pin-type head-holder (Pang, 1982; Case 2). |
| 10. ST-MC anastomosis (Pop et al, 1982). |
One is the "ball valve" mechanism and the other is the "inverted pop-bottle syndrome" (Lunsford, 1979). A "ball valve" mechanism requires a pressure difference between the intra- and extracranial cavities for air to enter. Air will enter according to the pressure difference, but the brain or meninges seal off the leak site temporarily to eliminate the exit of air. The "inverted bottle" mechanism is always associated with a CSF leak in which air replaces the lost fluid volume. Removal of CSF by lumbar puncture or CSF diversion will facilitate the entry of air into the head by releasing the tamponade (Davis et al, 1981; Pop et al, 1982). As CSF leaks through the fistulous connection with the extra-cranial space, air enters the subdural space and may act as a mass within the intracranial cavity and give rise to a pressure increase. This effect is similar to inverting a soda bottle, just as air rises to the top of the subdural space. After a lumbar puncture in Case 2, such a mechanism permitted the intake of air while preventing its release. Also, the air was warmed to body temperature which further increased the volume and pressure (Raggio et al, 1979).

The anesthetic agent also plays a role in tension pneumocephalus. As nitrous oxide will rapidly diffuse into a cavity so the partial pressure of the nitrous oxide in the cavity can equilibrate with that in the blood, nitrous oxide anesthesia may aggravate tension pneumocephalus by increasing the volume of the intracranial gas (Artru, 1982; Chiari, 1884; Saidman and Eger, 1965). In Case 1, such a mechanism might also be involved in building up the intracranial pressure.

**Conclusion**

Two cases of tension pneumocephalus from iatrogenic causes—one was due to the perforation by a pin of a head holder and the other was due to a dural laceration at pansinectomy—were presented.

It was concluded that CSF diversionary procedures play a role in building up the intracranial pressure and facilitating the entry of air, intracranially.

**Reference**


Grundy, B. L. and Spetzler, R. F. (1980). Sub-
dural pneumocephalus resulting from drainage of cerebrospinal fluid during craniotomy. Anesthesiology, 52, 269-271.


