Case Report

Tension pneumoventricle after resection of a fourth ventricle choroid plexus papilloma: An unusual postoperative complication

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Abstract

Background: Pneumocephalus is defined as the presence of air within the intracranial vault. A common complication of head trauma and surgery, pneumocephalus is usually related to ventricular shunts, craniotomies, and surgery in the sitting position. Tension (symptomatic) pneumoventricle is a rare entity associated with significant clinical morbidity.

Case Description: We report an unusual case of a 15-year-old girl with tension pneumoventricle developed shortly after removal of a choroid plexus papilloma of the fourth ventricle by a midline suboccipital approach while in the sitting position.

Conclusion: The presence of a cerebrospinal fluid (CSF) diversion system that causes a decrease in intracranial pressure and the existence of a craniodural defect with or without an obvious CSF leak may be the cause of tension pneumoventricle. According to our present understanding, this is the first report of this peculiar complication of fourth ventricular surgery. We discuss clinical manifestations, surgical management, contributing factors, and mechanisms involved in the pathogenesis of tension pneumoventricle.

Key Words: Choroid plexus papilloma, intraventricular pneumocephalus, pneumoventricle, postoperative complication

INTRODUCTION

Pneumocephalus is defined as the presence of air in the intracranial vault. It is commonly associated with head injury, craniotomies, or the insertion of a lumbar drain. Intraventricular pneumocephalus, also known as pneumoventricle, commonly follows cerebrospinal fluid (CSF) diversion procedures and fourth ventricular surgery. Pneumoventricle is mostly asymptomatic, not requiring treatment, and takes approximately 2–3 weeks for complete reabsorption of any air present. Tension pneumoventricle, which means the presence of air in the ventricles under pressure, is a rare incident that suggests a connection between the atmosphere and the intracranial cavity. We describe an unusual case of a sudden postoperative tension pneumoventricle, related with considerable clinical deterioration soon after surgery and improved with treatment. The patient underwent resection of a fourth ventricle choroid plexus papilloma via a midline suboccipital approach while in the sitting position.
CASE REPORT

History and examination
A 15-year-old girl presented with a 3-month history of mild episodic headache refractory to medical treatment. Neither consciousness impairment nor any comorbidities were observed. A neurological examination revealed bilateral extreme lateral and upward gaze nistagmus, global hyperreflexia, and bilateral papilledema, without hemorrhage signs. A radiological evaluation showed an abnormal mass lesion in the fourth ventricle. On a computed tomographic (CT) scan, the mass lesion was hyperdense with contrast enhancement [Figure 1a and b]. A well-delineated mass within the ventricle was present, determining a gross obstructive hydrocephalus and effacement of the convexity suli [Figure 1c]. Brain magnetic resonance imaging (MRI) was performed on the patient, demonstrating a large 3 × 4 × 3 cm³ intraventricular lesion with irregular contrast-enhancing margins [Figure 2].

Elective operation—Tumor resection
A midline suboccipital approach was used to excise the fourth ventricle tumor, while the patient was maintained in the sitting position. Concern that may be necessary to rapidly decompress the lateral ventricles intra- or postoperatively, a burr hole was drilled in the right posterior occipital region before the craniotomy was performed. There was no external drainage throughout the operation, but intravenous mannitol was administered. The fourth ventricle was exposed by separating the cerebellar tonsils, widening the vallae, and allowing tumor resection in an “en bloc” fashion.

Postoperatively, the patient presented with severe left palsies in the VI, VII, IX, and X cranial nerves (CN). She opened her eyes in response to voice, responded with exclamatory articulated speech and obeyed commands, with a Glasgow Coma Scale (GCS) score of 12. Approximately 4 hours later, systemic arterial pressure increased and the girl’s consciousness deteriorated: she did not open her eyes, uttered incomprehensible sounds, and localized painful stimuli, with a GCS score of 8. The CT scan, performed immediately after decline of the patient’s condition, revealed the presence of prominent intraventricular air with dilatation of the lateral and third ventricles as transependymal fluid passage [Figure 3]. The patient was rushed to the operating room.

Emergency operation—External ventricular drainage
Postoperative tension pneumoventricle was treated via the right occipital burr hole made during the elective operation. We chose our insertion site based on the patient's condition.
on the presence of an existing burr hole in the skull. Intracranial air gushed out under pressure through the external ventricular drain immediately after insertion. Approximately 60 mL of air was drained during occipital burr hole aspiration, resulting in pressure relief and clinical recovery. The patient’s consciousness level also improved to a GCS score of 12.

**Postoperative course**
The following day, a CT scan demonstrated a marked improvement of the pneumoventricle [Figure 4]. The patient was subjected to tracheostomy and gastrostomy. Thirteen days later, the external ventricular drain was removed from the patient. Her condition continued to improve (GCS = 15), and she was discharged on day 60 postoperative. At 9-month follow-up, the patient remains with mild left CN VI palsy and left peripheral CN VII palsy (House-Brackmann II). An MRI revealed total tumor resection [Figure 5]. Histopathological analysis demonstrated choroid plexus papilloma.

**DISCUSSION**

While pneumoventricle is common immediately after a CSF shunt procedure for hydrocephalus or head trauma,
Our patient experienced conscious level deterioration and arterial hypertension. The “valve mechanism” does not allow the air to escape, as the brain’s soft tissue blocks the “valve” defect on the exhalation cycle, causing a mass effect and increasing intracranial pressure. Risks also included sudden loss of CSF from enlarged lateral and third ventricles after removal of the tumor in the fourth ventricle, which was opened and explored in the course of surgery. The influx of air into the ventricle is greater in the presence of a noncompliant system because the ventricles do not collapse as the fluid is drained and more air fill it. Administration of mannitol may have enhanced the CSF loss by reducing the brain volume and decreasing the production of CSF. We believe that the progression to tension pneumoventricle also occurred by the presence of remnant blood in the fourth ventricle after surgery, thereby predisposing the patient to obstructive hydrocephalus. Our patient experienced conscious level deterioration and arterial hypertension. The postoperative CN palsies were probably due to surgical manipulation. Conduction to the operating room followed by external ventricular drainage to relieve the pressure caused by the trapped air improved her clinical condition. An effective approach is positioning the head of the patient so that the air is in the least dependent area and filling the ventricles with irrigation fluid. Intracranial hypertension can be detected by intracranial pressure monitoring in the postoperative period, but the benefits must be weighed against the associated complications, i.e. infection, limited patient’s movements. We report here a unique case of tension pneumoventricle after surgical management of a fourth ventricle tumor.

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. Prevention of this complication is made by proper layered closure. In the case of postoperative CSF leak treated with lumbar drainage, the drain must be removed immediately, since it favors more air intake. In our case, external drainage was not applied during surgery and we have not observed a wound with dehiscence as the possible entry point of air; neither the patient had a lumbar drain. Tension pneumoventricle probably occurred by the existence of a craniodural defect without an obvious CSF leak and a massive inflow of air with the patient in the sitting position. The “valve mechanism” does not allow the air to escape, as the brain’s soft tissue blocks the “valve” defect on the exhalation cycle, causing a mass effect and increasing intracranial pressure. Risks also included sudden loss of CSF from enlarged lateral and third ventricles after removal of the tumor in the fourth ventricle, which was opened and explored in the course of surgery. The influx of air into the ventricle is greater in the presence of a noncompliant system because the ventricles do not collapse as the fluid is drained and more air fill it. Administration of mannitol may have enhanced the CSF loss by reducing the brain volume and decreasing the production of CSF. We believe that the progression to tension pneumoventricle also occurred by the presence of remnant blood in the fourth ventricle after surgery, thereby predisposing the patient to obstructive hydrocephalus. Tension pneumoventricle may manifest as deterioration of consciousness, convulsions, focal neurological deficit, or cardiac arrest. Our patient experienced conscious level deterioration and arterial hypertension. The postoperative CN palsies were probably due to surgical manipulation.

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