Case Report

Delayed Recurrent Encapsulated Pneumocephalus: A Case Report and Review of the Literature

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Abstract

Pneumocephalus describes the presence of air inside the cranial cavity. It can be asymptomatic or have insidious progression resulting in tension pneumocephalus. The later requires an aggressive treatment as it can lead to neurological damage and death. The cause as well as the mechanisms of pneumocephalus varies. The treatment options are conservative for the asymptomatic patients and surgical for the more aggressive tension pneumocephalus. In our case we present a patient who after a craniofacial injury and surgery developed delayed pneumocephalus in the form of an air-cyst.

INTRODUCTION

Pneumocephalus is the clinical term used to describe air trapped inside the cranial cavity. It is not uncommon following traumas or surgeries and consists. A similar entity is the tension pneumocephalus [1] which manifests when the air-occupied space causes increased intracranial pressure (ICP) and generally requires emergent methods of treatment.

In this case report we present a patient which developed a form delayed encapsulated pneumocephalus.

CASE PRESENTATION

A 55-year old male assault victim was hospitalized in December of 2012 in our Neurosurgery Department. He had sustained facial injuries which resulted in multiple fractures of the roof of the right orbit and of the right frontal sinus with multiple dislocated fragments in the intracerebral parenchyma and hemorrhage. Furthermore he had an intraparenchymal hemorrhage on the right side of the frontal lobe with intrusion of the blood in the lateral ventricles. He was operated through a reconstruction of the base of the skull with plate osteosynthesis and drainage of the intracerebral hemorrhage. Two weeks later because of decreased level of consciousness the patient had to undergo a CT-scan of the brain, which showed air accumulation inside the cranium [2]. A surgical revision of the skull-base was decided. Through a transfenoidal approach the skull-base fracture was covered with fascia. The postoperative CT-scan showed a reduction of the intracranial air and the lining of the cyst wall which was now filled with fluid. The operation involved a debridement of the skull-base with duroplasty.

Currently the patient presented again with disorientation as a result of pneumocephalus. A defect of the right frontal sinus was found in the CT which was communicating with the right frontal cranial fossa. Air was accumulated in the epidural space and inside the parenchyma with the latter causing a 12mm midline shift. However there was no visible communication between those two air collections.

Intraoperatively an autologous fat graft was used to obliterate the frontal sinus. The frontobasal dura was found to be intact. Furthermore a burr hole was placed over the intracranial air cavity in order to aspirate the excessive air. Excessive resistance was noticed while trying to puncture the air cavity in order to evacuate the air. Therefore a mini-cranietomy followed. The dura was prepared, opened and below the dura we noticed a cyst-like wall. We opened the cyst which contained only air without any fluid accumulation. We reached the opposite wall of the cyst, opened it and below lied brain parenchyma. We filled the cyst with saline and we closed with duroplasty.

The postoperative neurological status of the patient was improved without any signs of disorientation. The CT-scan showed a reduction of the intracranial air and the lining of the cyst wall which was now filled with fluid. He was discharged with a follow-up control after two weeks.

After a month the patient presented again in our Emergency Department with disorientation [3]. The CT-scan showed a recurrence of the pneumocephalus. The operation that followed through a bifrontal craniotomy involved covering of the frontobasal skull with muscle-fascia and autologous fat graft from the patient’s abdominal wall. The graft was fixed using a...
titan mesh. Intradurally we placed another muscle-fat graft fixing it with fibrin glue und fibrinogen patch. The dura was closed with duroplasty. A biopsy was taken from the cyst wall which showed a cystic fiber-like tissue with chronic inflammation.

The postoperative control showed minimal air inside the brain cavity. Because of the pre-existing VP-Shunt, we thought of the following mechanism leading to recurrence: the shunt was draining cerebrospinal fluid thus creating a negative pressure inside the ventricles. That negative pressure would then result in the entry of air through a small non-visualisable defect in the dura. Therefore we decided to place the ventriculoperitoneal shunt at 200mmHg with close monitoring of the patient in case he developed hydrocephalus.

About 2 weeks later the patient was brought to the Emergency Department because of a fall. The CT of the brain showed a recurrence of the pneumocephalus. Furthermore he had trapped air under the skin of the forehead, at the level of the frontal sinus. In the operation that followed the right sinus was found to be closed without any signs of defect. We performed an exenteration of the left frontal sinus and then obliterated it with autologous fat and muscle-fascia graft from the abdomen wall. Additionally we covered the sinuses with fibrin glue and fibrinogen-thrombin patch. The postoperative CT-scans showed regression of the intracranial air (Figures 1-4).

Approximately a month later the patient presented with bilateral headaches [4]. The CT-scan showed the known pneumocephalus. We performed a CT-scan with intraventricular contrast agent, however no leakage was displayed. In the revision of the operation we did not find any dura defect, neither at the frontal nor at the sphenoid bone region. We opened the dura at the frontobasal skull, thus relieving the pneumocephalus and sealed it with continuous suture and fibrinogen-thrombin patch. We used again autologous fat graft and fibrinogen-thrombin patch to seal the frontal sinuses. Furthermore we decided to completely legate the ventriculoperitoneal shunt. The postoperative CT-scans were unremarkable without any signs of intracranial air or hydrocephalus. The patient was discharged at home. At three month follow-up the last CT displayed no evidence of recurrence of the pneumocephalus [5,6].

**DISCUSSION**

Pneumocephalus is the term used to describe the presence of trapped air inside the endocranium. The most frequent etiology of pneumocephalus is traumas, especially those involving the base of the skull and the paranasal sinuses. Moreover cranial surgeries, transphenoidal or endoscopic surgeries, ENT surgeries, tumors, invasive brain monitoring and air-producing bacteria leading to meningitis can result in pneumocephalus [7]. CPAP was found to be a potential cause of pneumocephalus in a case complicated with osteomyelitis of the base of the skull [4]. Pneumocephalus is described as early (<72 hours) and as late (>72 hours).

Most commonly pneumocephalus is seen occupying the subdural space. However it can be found in the epidural, subarachnoidal, intraventricular and intraparenchymal space. The frontal area is the most frequent forming site of a pneumocephalus.

When the pneumocephalus occupies enough space inside the cranial cavity causing increased intracranial pressure phenomena then it is termed tension pneumocephalus. The increased ICP can lead to midline shift, obliteration of the ventricular spaces.
Figure 3 Intraoperative. In the right Figure the cyst wall can be seen. In the middle after opening the cyst wall, the cyst is filled with air. In the third after opening the posterior cyst wall showing normal underlying brain.

Figure 4 Postoperative CT-scan. The air cavities are filled with saline. In this postoperative image the lining of the cyst wall is clearly shown (red arrows).

Figure 5 Recurrence of pneumocephalus after the first operation, which included the opening of the air cyst.

Spaces and even herniation leading to death. Therefore tension pneumocephalus is considered a neurosurgical emergency requiring emergent decompression.

There have been proposed 2 main mechanisms involving the formation of pneumocephalus. The first mechanism includes a ball-valve mechanism which consists of inflow of air because of Valsava maneuvers. When the positive pressure caused by the Valsava maneuver drops, the existing fistula is closed and air gets trapped. The second mechanism, called the inverted-soda-bottle effect, involves the inflow of air under negative pressure. The negative pressure produced by the CSF leakage causes air to enter the cranial cavity, thus replacing the lost CSF until the pressures in the two communicating areas equalize [6].

The radiologic modality of choice for visualizing pneumocephalus is Computed Tomography (CT). Characteristically pneumocephalus occupying the frontal space and causing compression of the frontal lobes takes on the appearance of a symmetrical mountain (Mount Fuji sign) [8]. Furthermore a pneumocephalus can be suspected from plain X-rays too [9] (Figures 5-7).

The treatment of pneumocephalus encompasses a variety of different modalities. There exists the conservative approach including supine or Trendelenburg position of the patient, avoidance of Valsava maneuvers and inhalation of 100% oxygen [6]. Antibiotics should be included in case of trauma especially if the sinuses are involved. The surgical interventions include burr hole over the air-filled cavity, needle aspiration and duroplasty to repair the defect [10].
CONCLUSION

Our case presents a rare phenomenon of encapsulated pneumocephalus. The persistence of the pneumocephalus in our patient was attributed to a negative pressure effect created by outflow of CSF thought the existing VP-Shunt of the patient. In the literature we found one article mentioning the presence of an air-cyst, which was evacuated surgically [11].

Pneumocephalus is a clinical condition consisting of trapped intracranial air. It can be the result of many medical procedures as well as traumas and infections. The pneumocephalus may decrease significantly the life quality of the patient. Tension pneumocephalus is a rare but potentially life-threatening complication and can occur delayed after neurological surgery [12]. The radiographic modality of choice is the CT scan. It can have a subtle onset and progression without symptoms until it manifests as tension pneumocephalus, a neurosurgical emergency in need of immediate intervention.

REFERENCES


Cite this article