



Case report

Pneumocephalus after posterior fossa surgery in prone position: Is that any clinical effect?

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ARTICLE INFO

Keywords:

Pneumocephalus
Posterior fossa
Neurosurgery
Epilepsy
Neurooncology

ABSTRACT

Introduction: The term pneumocephalus refers to the existence of air in any intracranial compartment. Its presence in the follows of a supratentorial craniotomy is very common, and it usually represents a benign complication as it is very rarely responsible for clinical manifestations.

Case presentation: We report the case of a 24 years-old man, who underwent posterior fossa surgery in prone position for resection of a vermian tumor. Postoperative, the patient presented a tonic-clonic generalized seizure associated to high levels of arterial pressure and decerebration. Control CT scan showed an important pneumocephalus. On the posterior fossa, the air was responsible for a compression of the brainstem, without any other postoperative complications. Following 12 h of conservative management, a brain MRI showed a total regression of the pneumocephalus. 3 days later, the patient presented a favorable outcome as he was extubated without any major impairments.

Discussion: Transformation of pneumocephalus into tension pneumocephalus responsible for clinical inadvertance is rare. This complication is mainly related to surgeries performed in sitting position. The occurrence of compressive pneumocephalus after a posterior fossa craniotomy performed in a prone position is seldom.

Conclusions: Through this case, we discuss pathophysiology and therapeutic approaches for tension pneumocephalus following posterior fossa performed in prone position.

1. Introduction

Pneumocephalus refers to the presence of intracranial air. The term encompasses gas in any of the intracranial compartments, and is most commonly encountered following trauma or surgery [1]. Pneumocephalus after supratentorial craniotomy is very common, reported in almost 100% of the patients [2,3]. However, compression of intracranial structures by the transformation of pneumocephalus into tension pneumocephalus responsible for clinical inadvertance is rare [4]. This complication is widely reported in the follows of a posterior fossa surgery performed in the sitting position [3,5]. The occurrence of compressive pneumocephalus after a posterior fossa craniotomy performed in a prone position is very rare [6]. We report the case of a young patient who developed brain-stem tension pneumocephalus in the early postoperative course after posterior fossa craniotomy for a medulloblastoma in prone position responsible for a clinical deterioration.

This work has been reported in line with the SCARE 2020 criteria

[7].

2. Case report

We report the case of a 24 years-old man, without any pathologic background, who presented due to the progressive onset since 1 year of headaches. The headaches were paroxysmal, associated to vomiting, and were progressively worsening in intensity and frequency. Since 2 months, added to these symptoms, the patient also reported episodes of dizziness. On physical examination, the patient was fully conscious, he had a static cerebellar syndrome. No signs of cranial pairs impairment or sensitivo-motor deficiency were found. Examination of the fundus found a grade I papilledema. Brain CT scan was performed (Fig. 1) showing a voluminous vermian heterogenous mass with a slight enhancement after contrast injection. This lesion was responsible for an important compression of the fourth ventricle thus an upstream triventricular hydrocephalus, as well as a tonsillar herniation. A cerebro-spinal MRI was

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<https://doi.org/10.1016/j.ijscr.2021.106736>

Received 14 October 2021; Received in revised form 23 December 2021; Accepted 23 December 2021

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also performed (Fig. 2) showing that the lesion was hypointense on T1-weighted imaging (WI), hyperintense on T2-WI, with a heterogenous enhancement after injection of Gadolinium. The interface between the tumor and the floor of the fourth ventricle was not seen, generating fears towards a possible infiltration of this structure. These radiological features were mainly suggestive for a medulloblastoma. Otherwise, spine MRI showed no evidence for metastatic localizations.

The patient underwent surgery. He was placed on strict prone position, the head was flexed and fixed on Mayfield's headrest, and logs were placed underneath his shoulders and humps. A median suboccipital approach was performed through suboccipital craniotomy enlarged to the posterior arc of C1 due to the tonsillar herniation. The dura was opened on Y-shape, giving access to the vermis. Following the vermectomy, a greyish, friable, non encapsulated tumor was found. The resection was performed using the ultrasonic aspirator. In the end of the resection, it was found that the floor of the fourth ventricle was not infiltrated, and the permeability of the cerebral aqueduct and the fourth ventricle could be checked. After completing tumor resection and control of the hemostasis, a profuse washing of the subarachnoid spaces was performed. The closure of the duramater was waterproof tight. The bony flap was re-fixed upwards an extradural suction drainage. Muscular, aponevrotic, subcutaneous and cutaneous plans were separately closed.

Postoperative, on the attempt of awakening of the patient, he presented a tonic-clonic generalized seizure associated to high levels of arterial pressure and decerebration. The patient was immediately re-sedated. A control CT scan (Fig. 3) showed no hematoma on the surgical site, nor a worsening of the hydrocephalus (which regressed comparing to preoperative imaging). However, we noticed the presence of an important pneumocephalus located on both supratentorial (sylvian fissure, suprasellar region) and infratentorial areas. On the posterior fossa, the air was anterior to the brainstem which was compressed and displaced posteriorly. Otherwise, all biological assessments were normal. The decision was to manage the patient conservatively with administration of corticosteroids and saline serum. Vitals parameters were stabilized after a few hours. 12 h after the CT scan, a brain MRI (Fig. 4) was also performed that showed a total regression of the pneumocephalus. Furthermore, there were no tumor residue, no stigmata for brainstem or cerebellar infarction. The tonsillar herniation also regressed.

Afterwards, the patient was maintained under sedation for another 48 h. Sedation was then progressively shut down, with a favorable response from the patient who progressively regained a perfect state of consciousness. He was extubated on the third day postoperative, and

discharged 1 week after surgery. He kept a sequellar static cerebellar syndrome without any other major impairments. Histological examination concluded to a classic medulloblastoma. The patient was referred to the oncological department for adjuvant radiotherapy and chemotherapy.

3. Discussion

Postoperative pneumocephalus is commonly observed following intracranial surgery. It is usually benign in nature as it is usually noticed on postoperative imaging without any related clinical symptoms. The amount of intracranial air varies, and approximately requires between 2 and 3 weeks for complete resorption [3,5]. Postoperative pneumocephalus may be compressive and source of concerns mainly in patients operated in sitting position. The pathophysiology of postoperative pneumocephalus is considered to be related to the perioperative loss of cerebrospinal fluid (CSF) and the subsequent intracranial entry of air, which corresponds to the "inverted soda-pop bottle" mechanism and moving to occupy the highest intracranial gap. Thus, sitting position, majoring the effect of gravity upon CSF loss, is frequently related to symptomatic postoperative pneumocephalus, as well as other relevant complications, mainly gas embolism [8]. But as in prone position, the cerebellum represents the top of the surgical field, filling the operative cavity with serum should theoretically, with tight suture of the duramater, avoid any major persistence of intracranial air.

Concerning our patient, we do think that despite prone position, the head level fixed above the heart level to minimize preoperative bleeding and optimize cerebellar relaxation, might have caused an upward migration of the air. We do also think that our relatively small craniotomy, performed as the tumor was strictly vermian, played a role as it only allowed a narrow access to an initially blocked vermis associated to a tonsillar herniation. This situation was source for air trapping without any possibility for escaping. We also think that the head should not be too upturned in order to facilitate the evacuation of gas by serum irrigation at the end of the operation.

Afterwards, and as the air heated joining the body temperature, the ideal gas law provides the explanation for the increase of the air volume, thus the compression of the neuroanatomical structures.

When reviewing the literature, we found only one comparable complication to that presented by our patient. Biyani et al. [3] reported the case of a patient who presented locked-in-syndrome. They supposed that it would be caused by a severe upper brainstem compression due to the tension pneumocephalus.

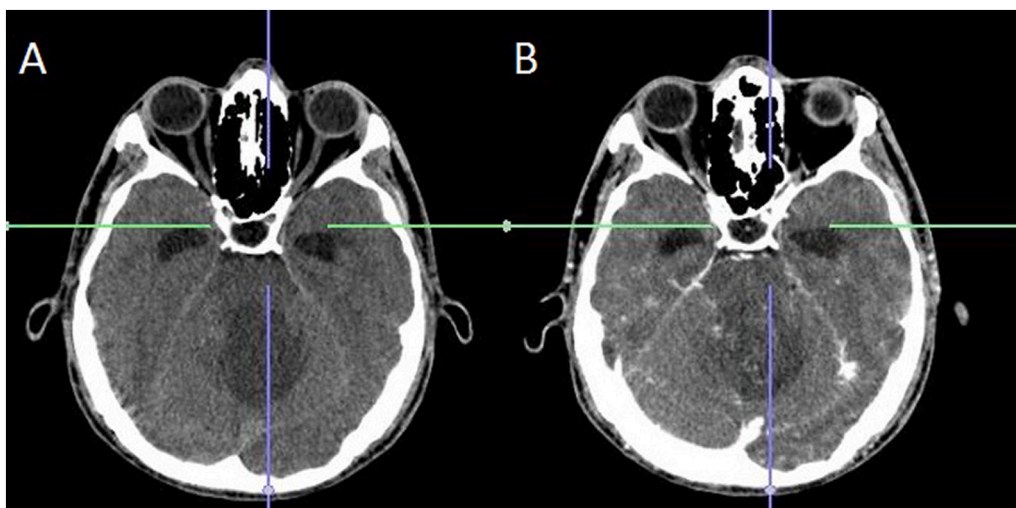


Fig. 1. Axial section of a brain CT scan before (A) and after (B) injection of contrast product showing a vermian hypodense lesion with a discrete enhancement after contrast injection. This mass is responsible for compression of the fourth ventricle thus an upward triventricular hydrocephalus.

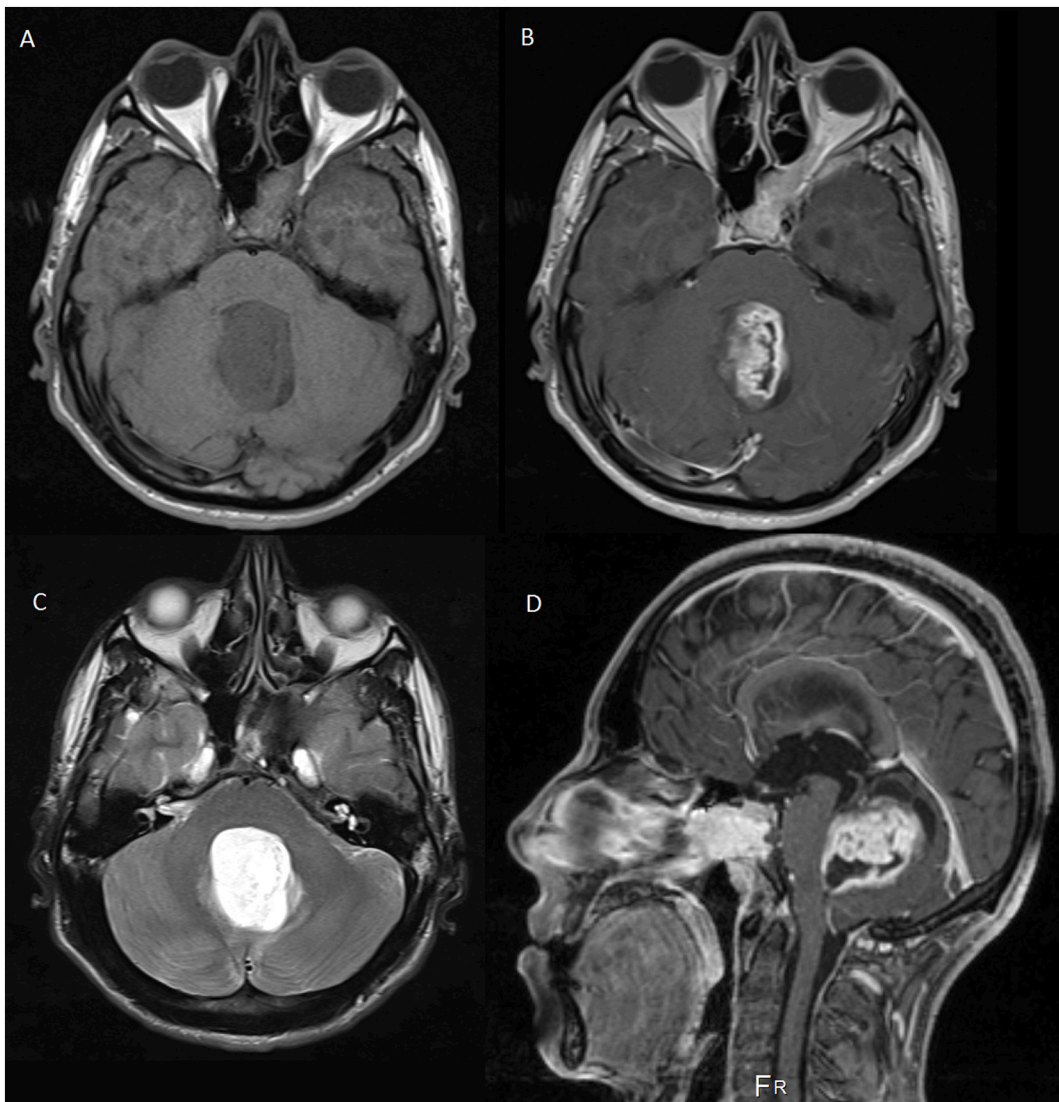


Fig. 2. Axial sections of a brain MRI on T1-WI without injection of Gadolinium (A), T1-WI with injection of Gadolinium (C) and T2-WI (B) showing a vermian mass which is hypointense on T1-weighted imaging (WI), hyperintense on T2-WI, with a heterogenous enhancement after injection of Gadolinium. Sagittal section on T1-WI with injection of Gadolinium (D) shows the tonsillar herniation as well as the important mass effect on the fourth ventricle.



Fig. 3. Axial (A B) and sagittal (C) sections of a brain CT scan without contrast injection showing postoperative pneumocephalus.

Clinical signs for tension pneumocephalus are represented by a deterioration of the state of consciousness, restlessness and seizures. Supratentorial tension pneumocephalus may cause neurological focal signs. Cases of cardiac arrest in patients operated in sitting position

without any other imputable causes were reported [2,9]. In our case, we think that decerebration and autonomic dysfunction may be related to the compression of the brainstem by the intracranial air.

Usually, postoperative pneumocephalus are asymptomatic and

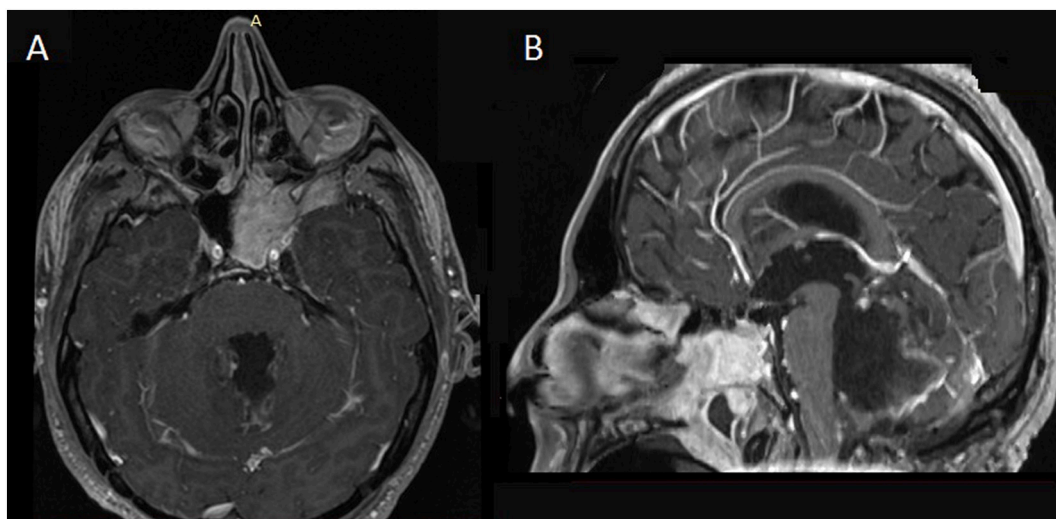


Fig. 4. Axial (A) and sagittal (B) sections of a brain MRI on T1-WI with injection of Gadolinium showing a total resection of the tumor, the regression of tonsillar herniation as well as of the pneumocephalus.

gradually resolve. But in some cases, like ours, in which mechanical compression is responsible for harmful clinical deterioration, a specific therapeutic approach should be discussed.

Supratentorial tension pneumocephalus can be evacuated through a frontal cannulation in order to replace the air by water [6,8]. For posterior fossa pneumocephalus, surgical approaches are more controversial. In “superficial” compressive air collections, a reintervention may be performed to evacuate the gas. But in cases like ours, there is no certainty about possibilities for evacuation of pneumocephalus located in “non-accessible” areas. In our experience, we decided to manage the patient conservatively with a favorable outcome.

Concerning the outcome for posterior fossa's tension pneumocephalus, Biyani [3] declared an unfavorable evolution for his patient. This was not the case for our patient who recovered a perfect state of consciousness without any major impairments. We do think that the difference was related to the volume of the collection, but also to its topography as Biyani's patient had a pneumocephalus responsible for an upward migration of the brainstem which was fatal.

4. Conclusions

Pneumocephalus may potentially be source for negative outcome. Thus, it should be prevented through irrigation of surgical bed and subarachnoid spaces, replacing any trapped air with fluid. Early recognition of the related symptoms associated to radiological confirmation is essential to trigger appropriate therapeutic approach.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Consent

Obtained.

Ethical approval

Non applicable.

Funding

None.

Guarantor

The corresponding author is the guarantor for this paper.

CRediT authorship contribution statement

GG wrote the manuscript, MR and AD made the bibliographic research, MZ prepared the iconography, IZ and MB corrected the manuscript.

Declaration of competing interest

The authors declare having no conflicts of interest related to this manuscript.

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