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Pneumocephalus: A Case Report and Mini-Review of Air Compressor - Induced Cases

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Abstract

Pneumocephalus is a rare event, commonly related to skull base, sinus, or open skull fractures due to head traumas. It is defined as the presence of air in the epidural, subdural, or subarachnoid space, within the brain parenchyma or ventricular cavities. Several cases of air compressor-induced pneumocephalus have been described in literature, including few cases in the pediatric age.

We describe the case of a child with extended pneumocephalus caused by an air compressor gun and review the available literature on this topic. Our aim is to suggest a management strategy in clinical practice for pediatricians and neurosurgeons.

Keywords: Pneumocephalus; Air compressor; Pneumocephalus management; Pediatric neurosurgery

Introduction

The term pneumocephalus defines the presence of gas within any of the intracranial compartments (intraventricular, intraparenchymal, subarachnoid, subdural, and epidural) and commonly is a consequence of skull base, sinus, or open skull fractures due to head traumas. Other causes could be post intrathecal procedure, congenital skull defect, neoplasm, gas-producing organism (meningitis, ventriculitis, chronic otitis media and sinusitis), barotrauma, post invasive procedures (i.e., lumbar puncture, ventriculostomy, spinal anesthesia), mask or nasal continuous positive-airway pressure and can rarely occur spontaneously [1]. Few case reports of air compressor-induced pneumocephalus are described in literature.

In this article, we present the case of a child with extended pneumocephalus caused by air compressor gun and review the available literature on this topic, with the aim to suggest a management strategy to apply in clinical practice.

Case Presentation

A previously healthy 7-year-old boy was admitted to our emergency department with chemosis of the left eye due to ocular trauma caused by an air compressor gun. The child hit his eye while he was trying to "brush his hair with the air". On physical examination he was conscious (GCS 15/15), collaborating, afebrile and in good clinical condition. Painful left palpebral extensive oedema, proptosis and periorbital swelling with mild crepitations on palpation characterized his left eye. No neurological deficits or meningeal signs were detectable. Ophthalmological examination described intact ocular motility, visual acuity and pupillary light reflex. An orbital and brain Computed Tomography (CT) revealed air in the left frontal area, Willis polygonus, ponto-cerebellar and quadrigemina cisterns without midline cerebral shift (Figure 1). There were no detectable skull base or facial fractures. The child was admitted in the neurosurgical department for clinical observation. Topical antibiotic eye drops and endovenous antibiotics were started (vancomycin 15 mg/kg TID plus ceftazidime 50 mg/kg TID). In addition, pneumococcal vaccine was recommended to complete the vaccination schedule. After 5 days, a brain Magnetic Resonance Imaging (MRI) revealed resolution of endocrine pneumocephalus and reduction of the air component also in the orbital area and retrobulbar adipose tissue. Endovenous antibiotics were carried on until day 14 from admission.

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Table 1: Characteristics of reported cases of air compressor-induced pneumocephalus, including our case (NA: Not Available).

Date [reference]	Age (Year)	Associated fracture	Radiological investigation	Conservative therapy	Antibiotic prophylaxis	Length of hospitalization	Neurological/ ophthalmic complication	Infectious complication
2006 [2]	4	No	Skull X-ray and CT	Yes	Yes (topical and systemic)	NA	No	No
2014 [3]	9	No	CT/Orbital MRI	Yes	Yes (topical and parental)	7 days	No	No
2002 [4]	16	No	CT	Yes	NA	NA	No	No
2020 [1]	18	No	CT	Yes	Yes (topical antibiotic)	24 hours	No	No
2007 [9]	22	No	CT	Yes (Suture of conjunctival laceration)	Yes (topical and systemic)	NA	No	No
1999 [10]	47	No	CT	Yes (irrigation and debridement of conjunctival wound)	Yes (topical and oral)	NA	No	No
2016 [11]	62	No	CT	Yes (closure on the eyelid Lacerations and canalicular repair)	Yes	4 days	Yes (Optic nerve injury)	No
2020 (Current case)	7	No	CT	Yes	Yes (topical and parental)	15 days	No	No

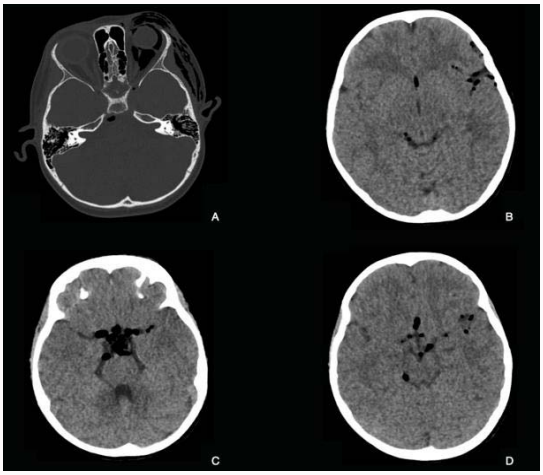

Figure 1: CT axial scan performed on admission showed no fracture lines on bone window associated with endo-orbital air in the left retrobulbar adipose tissue (A); pneumocephalus in the left frontal lobe, circle of Willis, Sylvian fissure, interhemispheric fissure not associated with midline shift and traumatic parenchymal lesions, with regular dimension and localization of ventricular structures (B, C, D).

Discussion

Pneumocephalus (PN) is defined as the presence of air in the epidural, subdural, or subarachnoid space, within the brain parenchyma or ventricular cavities. It can be congenital, traumatic (the most common cause), infectious, neoplastic, iatrogenic or spontaneous. It is classified as simple or, more rarely, tension PN [1].

The CT is the gold standard investigation in the diagnosis of PN, as it can detect as little as 0.55 mL of air in the brain. MRI may also be useful, but not as sensitive as CT scan [1].

There are few case reports of unusual facial injuries as a cause for PN, secondary to accidental air compressor injury [2-8]. These data are summarized in Table 1. Interestingly, all the previous case reports included compressor tip injuries to one or both eyes without any documented skull fractures.

Given the lack of bony fractures, we agree that the most likely explanation is air entry to the cranial cavity *via* dissection beneath the Tenon fascia, around the optic nerve, and through the optic canal into the subarachnoid space, as firstly postulated by Williams and Frankel in 1999 [6].

High-pressure injury to the orbit could be responsible of direct contusion to the orbital contents (as in our case), traumatic optic atrophy with subsequent poor vision, injection of foreign bodies inside the conjunctiva with risk of infection and inflammation, displacement of the orbital contents with proptosis and fractures [2,3].

In the majority of cases PN is asymptomatic, because intracerebral air is generally well tolerated [1]. Similarly, to our patient, also in previous studies patients with air compressor-induced PN presented severe pain and swelling of the eyelids and face, without neurological deficits or meningeal signs.

Despite this, on rare occasions PN might result in tension PN, a neurosurgical emergency that might lead to brainstem herniation and death [10].

Twenty cases of post-traumatic tension PN are reported in literature, mostly associated with severe craniofacial fractures. The imaging appearance of tension PN should be correlated with clinical signs of deterioration or visual symptoms and may require emergent treatment (decompression such as with a burr hole and/or with needle aspiration) [10].

Seizures can sometimes occur by irritating the cerebral cortex; moreover, the risk of meningitis and brain abscesses deserves to be mentioned.

PN secondary to air compressor injury is a rare event and no guidelines on its management are currently available.

Our case, as well as the other similar ones reported in literature, has been treated conservatively. Conservative management includes bed rest, maintaining a supine position, the use of normobaric oxygenation, the avoidance of Valsalva maneuver (like nose-blowing, coughing, and sneezing), analgesics, antipyretics and administration of prophylactic antibiotics. The use of hyperbaric oxygenation may be useful in the management of symptomatic persistent PN [9].

It is important to report that, to date, there is no evidence supporting the prophylactic use of antibiotics in patients with basilar skull fractures, with or without PN [12].

However, our concern was that, although we know that high pressure in the compressor could affect microorganisms' gene expression and protein synthesis and could induce enzyme denaturation [11], the air entered intracranially through a non-sterile passage. Gram-positive bacteria are more resistant to

pressure than Gram-negative bacteria [11]. As we believed that early antibiotic prophylaxis should be started, we decided to use broad-spectrum antibiotics, particularly effective against Gram-positive microorganisms. Almost all previous reported patients received prophylactic antibiotics, but in the majority of cases authors did not specify which molecules and timing they choose. Even if our approach is not supported by specific literature, the significantly extended not sterile intracranial air allowed us to use aggressive antibiotic prophylaxis with centrally active antibiotics. We decided to continue this antibiotic treatment until the complete reabsorption of PN. No adverse reactions to antibiotics have developed as well as any infectious complications. Considering pneumococcus as one of the most common infecting organisms in PN secondary to trauma, we also suggest an anti-pneumococcal vaccine.

To the best of our knowledge, this is the first mini-review of air compressor-induced PN currently available. Despite this injury being rare, some cases have been reported, especially in the pediatric age. Prognosis is usually good, as in our case. Few simple steps should be followed to conservatively treat PN and prevent its possible complications.

Conclusion

Despite air compressor induced-pneumocephalus is usually a rare event, it could be useful for pediatricians and neurosurgeons to follow a few simple steps for better management.

We suggest conservative management including clinical observation, bed rest, maintaining a supine position and avoidance of Valsalva maneuver. Depending on clinical status, remember to consider normobaric or hyperbaric oxygenation; in the rare case of tension PN, urgent neurosurgery could be considered. We also recommend the use of broad-spectrum antibiotic prophylaxis in addition to anti-pneumococcal and anti-tetanic vaccine, in order to complete vaccination schedule. An infectious disease consultation could be indicated. Finally, not forget to remember to avoid diving and air travelling at the time of the discharge.

Authors' Contribution

All authors significantly contributed to the present manuscript. Dr. Pruccoli G and Dr. Vania B reviewed the literature and wrote the manuscript; Dr. Scolfaro C, Dr. Pacca P and Dr. Pilloni G defined the clinical management of the patient and contributed to the writing of the article; Dr. Mignone F, Dr. Denina M, Dr. Silvestro E and Dr. Garazzino S reviewed the literature, corrected the manuscript and edited English style. All authors read and approved the final version.

References

1. Das JM, Bajaj J. Pneumocephalus. In Treasure Island (FL). 2020.
2. Erdem Y, Karatay M, Sertbas I, Celik H, Bayar MA. Air compressor-induced pneumocephalus, pneumomediastinum, and extensive emphysema. Pediatr Neurosurg. 2013;49(4):256-7.
3. Kang BS. Disseminated head and neck emphysema with pneumocephalus due to air compressor injury into orbit. Am J Emerg Med. 2007;25(2):223-5.
4. Ko SW, Lee JS, Choi HS, Ko YG, Hong HP. Near-complete optic nerve transection by high-pressure air. Clin Exp Emerg Med. 2016;3(3):190-2.
5. Suisa H, Sviri GE. Disseminated pneumocephalus secondary to air compressor injury. Acta Neurochir (Wien). 2020;162(3):509-12.
6. Williams TR, Frankel N. Intracerebral air caused by conjunctival laceration with air hose. Arch Ophthalmol. 1999;117(8):1090-1.
7. Yildiz A, Duce MN, Ozer C, Apaydin FD, Egilmez H, Kara E. Disseminated pneumocephalus secondary to an unusual facial trauma. Eur J Radiol. 2002;42(1):65-8.
8. Yuksel M, Yuksel KZ, Ozdemir G, Ugur T. Bilateral orbital emphysema and pneumocephalus as a result of accidental compressed air exposure. Emerg Radiol. 2007;13(4):195-8.
9. Paiva WS, de Andrade AF, Figueiredo EG, Amorim RL, Prudente M, Teixeira MJ. Effects of hyperbaric oxygenation therapy on symptomatic pneumocephalus. Ther Clin Risk Manag. 2014;10:769-73.
10. Pillai P, Sharma R, MacKenzie L, Reilly EF, Beery PR, Papadimos TJ, et al. Traumatic tension pneumocephalus - Two cases and comprehensive review of literature. Int J Crit Illn Inj Sci. 2017;7(1):58-64.
11. Smelt JPPM. Recent advances in the microbiology of high-pressure processing. Trends Food Sci Technol. 1998;9(4):152-8.
12. Bo R, Costa J, Pappamikail L, Sampaio C. Antibiotic prophylaxis for preventing meningitis in patients with basilar skull fractures. Cochrane Database Syst Rev. 2015;(4):CD004884.