CASE REPORT

PNEUMOCEPHALUS AND CSF LEAK SECONDARY TO SKULL BASE FRACTURE BY PYROTECHNICAL OBJECT: CASE REPORT

Neumoencéfalo y fístula de LCR secundarios a fractura de base de cráneo por objeto pirotécnico: reporte de caso

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ABSTRACT

Introduction: Pneumocephalus is mainly associated with traumatic injuries, being a rare complication but with high mortality rates; it behaves like a space-occupying lesion and increases intracranial pressure. The symptoms are not specific, but in the event of trauma it is necessary to suspect this entity to carry out a timely diagnosis and treatment, since being the product of the skull base fracture it can cause communication with the outside, and the appearance of cerebrospinal fluid (CSF) leak.
Clinical Case: a 38-year-old male patient who suffers trauma from a pyrotechnic explosion near his right ear, when handling a pyrotechnic object (whistle) during the New Year, presenting severe pain, slight bleeding in the right ear, feeling faint and holocranial headache that increased in a standing position; likewise, he presents high-flow aqueous secretion (CSF) from the right ear. Brain and skull base tomography (CT) showed air in the intracranial cavity, fracture of the skull base, and the ossicles of the right middle ear. Conservative management was performed using rest and lumbar drainage, presenting a satisfactory evolution.
Conclusion: Pneumocephalus is a frequent and expected complication of trauma with a skull base fracture. Its early and timely diagnosis using skull base CT is essential to define therapeutic measures. Accidents due to the misuse of pyrotechnics continue to be a relevant problem in our country. Knowing and disseminating its consequences can help raise awareness in the population.

Keywords: *Pneumocephalus, Skull Base, Intracranial Pressure, Cerebrospinal Fluid Leak. (Source: MeSH NLM)*

RESUMEN

Introducción: El neumoencéfalo se asocia principalmente a lesiones traumáticas siendo una complicación poco frecuente, pero con altos índices de mortalidad; se comporta como una lesión ocupante de espacio y aumenta la presión intracraneal. La sintomatología no es específica, pero ante un traumatismo es necesario sospechar de esta entidad para realizar un diagnóstico y tratamiento oportunos, puesto que al ser producto de la fractura de base de cráneo puede originar una comunicación con el exterior, y con ello la aparición de una fístula de líquido cefalorraquídeo (LCR).
Caso Clínico: Paciente varón de 38 años quien al manipular un objeto pirotécnico (silbador) durante el año nuevo, sufre traumatismo por estallamiento de pirotécnico cerca de su oído derecho presentando dolor intenso, leve sangrado en oído derecho, sensación de desvanecimiento y cefalea holocraneal que aumentaba con la bipedestación; así mismo presenta secreción acuosa de alto flujo (LCR) por oído derecho. Tomografía cerebral y de base de cráneo (TEM) mostró aire en cavidad intracraneal, fractura de base de cráneo y de huesecillos del oído medio derecho. Se realizó manejo conservador mediante reposo y drenaje lumbar, presentando una evolución satisfactoria.
Conclusión: El neumoencéfalo es una complicación frecuente y esperable ante un traumatismo con fractura de base de cráneo. Su diagnóstico temprano y oportuno mediante la TEM de base de cráneo es fundamental para definir las medidas terapéuticas. Los accidentes por mal uso de pirotécnicos siguen siendo una problema relevante en nuestro país. Conocer y difundir sus consecuencias puede ayudar a generar conciencia en la población.

Palabras Clave*: Neumoencéfalo, Base de Cráneo, Presión Intracraneal, Pérdida de Líquido Cefalorraquídeo (Fuente: DeCS Bireme)*

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Pneumocephalus, also known as intracranial aerocele or intracerebral pneumatocele, is defined as the presence of gas within any of the intracranial compartments of the cranial vault (intraventricular, intraparenchymal, subarachnoid, subdural, and epidural).[1] The first description of intracranial pneumocephalus was made by Thomas in 1866.[1] Chiari, in 1884, reported on the autopsy results of a patient who had pneumocephalus as a complication of chronic ethmoid sinusitis.[2] Luckett used plain radiographs of the skull in 1913 for the diagnosis of pneumocephalus. The term pneumocephalus was first coined and used by Wolff in 1914.[3]

In 1967 Markam conducted a study to classify the etiological factors involved. It analyzed 284 cases of pneumocephalus of which 73.9% (n: 218) were secondary to trauma, 12.9% (n: 38) neoplastic, 8.8% (n: 26) infectious and only 0.7% (n: 2) of unknown cause.[5] Among the causes of unknown etiology for Markam, the otological origin is presented. Andrews analyzed 54 cases of otological pneumocephalus and reported that traumatic origin was the main cause and represented 36%, followed by otitis media in 30%, otological surgery in 30%, and congenital defect in 2% .[4,6-7]

Cerebrospinal fluid (CSF) fistula is relatively common in patients with a skull base fracture. A fistula, defined as the abnormal outflow of CSF to the outside, is generally produced by a tear of the dura and arachnoid, which allows communication of the subarachnoid space with the outside. Thus, there is a solution of continuity between the bone barrier and the meninges (osteomeningeal gap), generating communication between the endocranium and the exocranium. This communication occurs mainly towards the cavities related to the skull base: frontal and sphenoid sinuses, ethmoid cells, Eustachian tube, and mastoid cells.[8,9]

Traumatic CSF ear fistula occurs in 1% to 3% of all hospitalized head trauma patients (TBI); its frequency rises to 6% in skull base fractures. Studies have shown an incidence of CSF fistula secondary to temporal bone fracture that ranges between 15% and 45%.[1,2] This would occur more frequently in temporal fractures of a transverse feature. However, Dahiya et al10 suggest that the involvement of the otic capsule in temporal bone fractures is a more relevant parameter than the geometry of its line. In most cases, the diagnosis is obvious, based on a history of severe trauma and the development of otorrhea. However, the diagnosis can be difficult and delayed in some patients if the CSF leak by the ear is inconspicuous, intermittent, or with no way out, or when there is an undamaged tympanic membrane. In these situations, the patient may present with recurrent meningitis or fluctuating conductive hearing loss. In doubtful cases, the measurement of glucose in the CSF leak can serve as a guide. A highly sensitive, specific, and non-invasive method to determine the nature of an otorrhea is the qualitative determination of ß2-transferrin, a protein present exclusively in the CSF.[11]

The images constitute important support in the diagnosis: the high-resolution rock tomography (CT) would reveal 70% of the bone defects in patients with clinical CSF fistula. In those cases, in which the CT scan is negative, the study should be complemented with radioisotopic cisternography or CT-cisternography (intrathecal metrizamide).[12] The management of post-traumatic otorrhea is conservative. 77-90% of CSF fistulas resolve spontaneously within two weeks, taking an average of four days to close.[13,14] This is especially true for middle fossa fistulas, due to extensive fibrosis promoted by a rich plot of arachnoids in this area.[5] Treatment consists of maintaining strict rest in a semi-Fowler position (head elevated), avoiding coughing and sneezing. CSF drainage can be done through repeated punctures or the placement of a spinal catheter.

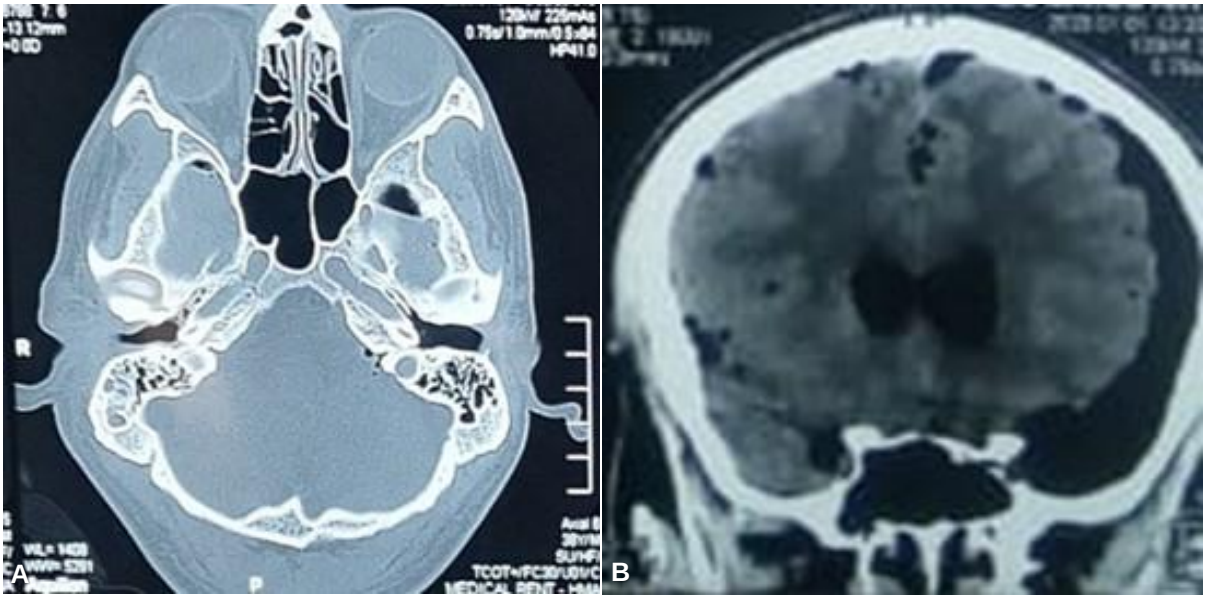

Fig 1. (A) Brain tomography in axial view and a bone window showing mastoid cells occupied by a fluid due to skull base fracture. **(B)** Cerebral tomography in coronal view and a parenchymal window showing pneumocephalus predominantly in the left frontal region, in basal cisterns, subarachnoid space, and lateral ventricle, effacement of sulci and fissures, with a slight deviation from the midline.

CLINICAL CASE

History and examination: 38-year-old male patient, native and from Lima, Villa María del Triunfo district, with no medical history who was admitted to the emergency room of this hospital ("María Auxiliadora") with a clinical picture of 1 h of evolution characterized by intense pain and slight bleeding in the right ear, feeling light-headed, holocranial headache that increases when standing, associated with nausea and vomiting, caused by the explosion of a pyrotechnic object ("whistle") near his right ear.

On physical examination: Patient awake, complaining, lucid, and oriented in time, space, and person. There was evidence of non-active bleeding through the right external auditory canal (EAC)

During the 11 hours following the trauma, leakage of high-flow crystalline fluid (CSF) was evidenced from the right EAC, as well as a sensation of thermal rise (38.4 ° C). A cerebral tomography (CT) showed the presence of pneumocephalus predominantly in the left frontal region, in cisterns around the brain stem, and in the lateral ventricle, effacement of sulci and fissures, with a slight deviation from the midline (<5 mm). The bone window showed a fracture line in the right sphenoid wing, as well as liquid collection in mastoid cells on the right side. *(Fig 1)* He was hospitalized with the following diagnoses: Acoustic trauma, skull base fracture, CSF fistula, and pneumocephalus.

Treatment: He received antibiotic therapy: Ceftriaxone 2 gr IV every 24 hours, clindamycin 600 mg IV every 8 hours, for 21 days, acetazolamide 500 mg every 8 hours for 15 days, mannitol 20% with an initial dose of 1 g / kg/day that then it gradually decreased until his retirement on the 6th day of hospitalization.

He was evaluated by the Otolaryngologist, who upon examination found: EAC with clear fluid, scant otorrhagia without bad smell, tympanic membrane was not visualized; concluding as diagnoses: ear trauma, probable right tympanic membrane rupture, acoustic trauma. He suggested IV corticosteroid treatment and continued IV antibiotic therapy. He requested multi-slice spiral tomography (spiral CT) of the auditory canals, which revealed a fracture in the ossicles (hammer and stapes), with a displacement of bone fragments to the mesotympanic region, blood collection in mastoid cells and right tympanic cavity.

On day 21 of hospitalization, a lumbar puncture and drainage were performed to reduce the leakage of cerebrospinal fluid (otic CSF fistula) through the EAC. *(Fig 2)*

Clinical evolution: The patient evolved favorably after 24 hours of lumbar drainage, presenting remission of the CSF outflow through the right ear, which indicated the closure of the otic CSF fistula. A control brain tomography on day 26 of hospitalization showed that the pneumocephalus had decreased significantly, so, being the patient asymptomatic, afebrile, it was decided to discharge him home. *(Fig 3)*

DISCUSSION

Otic CSF fistula is an infrequent but serious complication, both in otological surgery and in brain traumatic injury (BTI), since it constitutes a gateway for severe infections of the central nervous system (CNS). [13]

Headache, the predominant symptom, as well as fluid leakage are the most frequent clinical manifestations that guide the diagnosis of CSF fistula [5,15] This clinical picture agrees with that of our patient since, in addition to CSF leakage, the headache was predominant.

Pneumocephalus is generally associated with a loss of bone continuity after head or facial trauma, a skull base tumor, or after neurosurgical or ENT procedures, and that, on rare occasions, can also occur spontaneously, without obvious cause. Pneumocephalus occurs in 3–9% of patients with BTI and up to 90% of those undergoing craniectomy. [4,5]

Fig 2. (A) Placement of a continuous lumbar drain at the L4-L5 level. **(B)** The drain remained for 3 days and was then removed when the CSF leakage subsided.

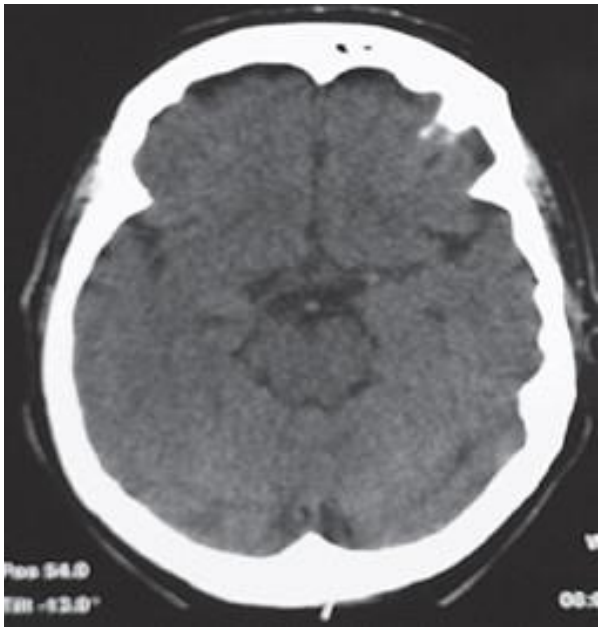

Fig 3. Brain tomography on day 26 of hospitalization shows almost total remission of the pneumocephalus.

The etiology is diverse, among them we have a cranial base fracture that involves the petrous bone and the sphenoid bone, as in our case in which the patient presented a temporal bone fracture in the tympanic and petrous region. Other causes are microsurgical procedures, the use of osmotic diuretics in the intraoperative period, the use of bypass in the treatment of hydrocephalus, the duration of the surgical intervention, the use of nitrous oxide in anesthesia, and the position of the patient during surgery. [10,12,13]

Two theories explain the occurrence of pneumocephalus: The first is that it is due to a leaked product of the injury that causes a decrease in intracranial pressure causing air to enter during exhalation or during coughing, occasions when intracranial pressure increases and second, due to a valve mechanism in which the penetration hole allows air to enter but does not exit. [16]

The intensity and duration of symptoms depend on intracranial air distribution and are related to air volume. When the volume is small, the patient is asymptomatic or shows nonspecific signs and symptoms, sometimes diagnosed after routine imaging. The clinical manifestations can occur immediately after the trauma, days, or weeks after the injury, the most common being: holocranial headache and changes in the level of consciousness. In our case, headache and vestibular symptoms predominated, as well as otorrhagia (an indication of a skull base fracture) initially, and later otorrhea due to the appearance of a traumatic CSF fistula. [5]

In most cases, the initial treatment of CSF fistulas is conservative, since they resolve spontaneously in 77-90% of cases during the first two to four weeks after trauma. For this reason, no invasive procedure is indicated in the initial period, performing only evolutionary clinical control, and medical treatment aimed at reducing intracranial pressure (ICP) and allowing the osteomeningeal gap to close. Said treatment consists of semi-sitting rest, laxatives, to reduce efforts to the closed glottis (therefore, ICP), and Acetazolamide, which reduces the formation of CSF. This occurred in the present case, in which the patient received conservative medical treatment with unfavorable clinical evolution as the fistula continued with high output.[6, 7, 11]

In cases in which after 2 weeks the fistula does not resolve and remains with high output, it is chosen to place a continuous lumbar drain, which is a minimally invasive procedure, with a very low rate of complications. Continuous lumbar drainage can complement medical treatment, to drain CSF, reducing ICP, and allow the defect in the skull base to be closed. It is a valid and recommended option, which should be evaluated in each patient according to the type of fistula, the magnitude of flow, the time elapsed since the trauma, and location.[8, 9, 13, 14, 15]

In our patient, the next step was the use of spinal drainage, the most recommended alternative being the placement of an epidural catheter at the level of L4-L5 for continuous drainage, reducing the pressure and, consequently, the flow of CSF through the fistula. After 24 hours, the absence of CSF leakage was evidenced through the right EAC, and in 72 hours the lumbar drain was removed, with the patient presenting a favorable evolution of the patient with complete closure of the fistula.

CONCLUSION

Pneumocephalus is a frequent and expected complication of trauma with a skull base fracture. Most of the cases have a favorable evolution and are resolved with conservative treatment. Its early and timely diagnosis using computerized axial tomography of the skull is essential to define therapeutic measures.

Accidents due to the misuse of pyrotechnics continue to be a relevant problem in our country. Knowing and disseminating its consequences can help raise awareness in the population.

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Ethical aspects
The patient was informed about the publication of the case and the use of her photos, obtaining informed consent, attachments in the history under strict confidentiality

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Authors Contributions
Conception and design: All authors. *Drafting the article:* Palacios. Critically revising the article: Bautista, Palacios, Rosas. *Reviewed submitted version of manuscript:* Bautista. *Approved the final version of the manuscript on behalf of all authors:* Bautista, Palacios.

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