Traumatic Brain Injury (TBI) Caused by a Piece of Wood in the Temporal Region: literature review

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ABSTRACT

Background: Non-missile penetrating brain injuries are rare. In most cases, the entry hole occurs in the orbital region. We present the case of a traumatic brain injury caused by a piece of wood entering the temporal area. Case presentation: an 11-year-old female child from a rural place in the Amazon forest was accidentally hit by a blunt object while walking along a street during a storm. She presented with a sharp wound in the left preauricular region at the level of the temporal region, which was sutured at the local hospital. Her parents took her to the State capital. After 12 hours, she got to the tertiary hospital, where a brain CT scan revealed a linear hypodensity in the left temporal lobe with attenuation similar to air. A small temporal craniectomy that showed a piece of wood was carried out. Conclusion: Unintentional brain injuries caused by wooden objects are rare but should always be suspected when a head CT scan shows a “linear pneumocephalus.”

Keywords: Traumatic brain injury; Wood; Foreign body; Temporal bone; Penetrating injury

RESUMO

Introdução: Lesões cerebrais penetrantes causadas por não projétil de fogo são raras. Na maioria dos casos, o orifício de entrada ocorre na região orbital. Apresentamos o caso de uma lesão cerebral traumática causada por um fragmento de madeira penetrando o cérebro na região temporal esquerda. Relato de caso: menina de 11 anos de idade residente em área rural da floresta amazônica foi acidentalmente atingida por um objeto contundente enquanto caminhava por uma rua durante uma tempestade. Apresentou-se com ferimento perfurocortante na região pré-auricular esquerda ao nível da região temporal, que foi suturado no hospital local. Seus pais a levaram para a capital do Estado. Após 12 horas, chegou ao hospital terciário onde uma tomografia computadorizada de crânio evidenciou uma lesão com hipodensidade linear no lobo temporal esquerdo com atenuação semelhante ao ar. Realizamos uma pequena craniectomia temporal que revelou um pedaço de madeira. Conclusão: Lesões cerebrais não intencionais causadas por objetos de madeira são raras, mas sempre devem ser suspeitadas quando uma tomografia computadorizada de crânio mostra um “pneumoencéfalo linear”.

Palavras-Chave: Traumatismo cranioencefálico; Madeira; Corpo estranho; Osso temporal; Lesão penetrante

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Review

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INTRODUCTION

Traumatic brain injury (TBI) is considered the leading cause of death and disability worldwide, especially among young adults. More than one million people live with neurological sequelae resulting from TBI in Brazil. Between 2008 and 2012, they were responsible for 9,175 deaths, corresponding to a mortality rate of about 5.1 per 100,000 inhabitants per year\(^1\). In Brazil, we did not find epidemiological data on cases of TBI related to penetrating brain injury (PBI). However, in the United States, the incidence of PBI is estimated as 12 per 100,000 cases\(^2\).

Most traumatic brain injuries (TBI) due to wooden objects described in the literature present a mechanism of perforating orbicularis trauma. Especially young children, they fall from their height with a wooden object in their hands. Unintentional and accidental intracerebral injuries by a wooden object are rare. If the trauma is mild and without clinical significance, the diagnosis of brain injury will be difficult and may go unnoticed during the initial clinical evaluation. These trauma mechanisms are uncommon in clinical practice, and we need to consider them to prevent late diagnosis. This case illustrates an unusual brain trauma mechanism and may help healthcare professionals in diagnostic suspicion and therapeutic management.

CASE PRESENTATION

An 11 years-old female child from Tefé, a small city in the Brazilian Amazon forest, while walking in the street during a rainstorm, was hit by an object. Evaluation at the local hospital depicted a blunt lesion in the temporal region which was sutured. She had no loss of consciousness, but her parents decided to go to a referral center in Manaus for further evaluation. She went to Manaus by boat, and, after 12 hours, she presented at the emergency department complaining of pain in the left temporal region, conscious, with a Glasgow Coma Scale of 15, with a sutured scalp lesion in the left temporal area (Figure 1A). It was not noticed any sign of speech disturbances. Head CT scan showed a hypodense linear parenchymal lesion in the left temporal lobe, approximately 30 millimeters long, with pneumocephalus, minor contusion, and associated perilesional edema (Figure 1B, 1C).

A linear incision taking advantage of the sharp wound to expose the temporal region was performed. The temporal muscle was swollen, and there was no sign of infection. After exposing the temporal bone, it was identified a comminuted fracture. Then a temporal craniectomy was done surrounding the fracture enough to expose all the dural laceration. It was found a wood fragment that was extracted (Figure 2A), as well as the hematoma. The brain was irrigated with saline solution to look for other wood fragments and minimize the risk of late infection. Afterwards, we sutured the dura using aponeurotic galea and muscle, followed by skin closure. The postoperative CT scan was carried out in the following day (Figure 2B).

During the entire disease process, the patient remained clinically stable, and uneventfully. She was discharged without neurological sequelae after five days of intravenous antibiotic (Ceftriaxone). Three months later, no complications were seen. The patient remained clinically stable during the entire disease process, obtaining medical discharge without neurological sequelae.
Most published case reports of TBI caused by wooden objects present a primary injury entry point in the orbit. In a series of 42 patients, Miller et al. found that periorbital perforations by sharp wooden objects are not rare but can be dangerous when there is intracranial retention of the wooden foreign body. A rare case was reported by Ildan et al. where a seven-year-old child fell with a pencil in her hand and pierced her right eye. The wood fragment pierced the skull reaching the brainstem. At that time, the authors highlighted the difficulty of identifying the wood in the imaging exam and found that it would favor bacterial infection as it was biological material.

It may elapse days or years post a trivial initial injury to become severe intracranial complications, where permanent neurological sequelae may occur in 74% of cases. Intracranial suppuration is the main complication, with brain abscess occurring in almost half cases. Although our patient lived in a city 550 km away from the capital Manaus, she was early evaluated (considering that the suspicion of a brain injury was not clear and the patient had a GCS of 15). Even though Amazonas is the largest state in Brazil, the only city with CT scan and neurosurgeon availability is the capital Manaus.

Conducting a search in Pubmed database (mesh terms: ‘traumatic brain injury’ and ‘wood’), only a few cases reports were identified, and just three of them had the temporal region as an entry point. The first one was a chopstick that perforated the temporal bone and caused a cerebellar lesion. The second one was caused by wood fragments from an explosive firework (Table 1). All cases but one were managed conservatively where only the extraction of a pencil that reached the brainstem was taken off under CT scan guidance.

As shown, the main issue of penetrating TBI due to wood is the possibility of overlooking such lesions. Wood has a low attenuation coefficient pattern and may easily be confused with pneumocephalus, according to Andereggen and Beck and are often associated. The question is that in case of no suspicions, infectious complications may worsen the prognosis. An appropriate cranial CT scan should include various window settings to assess detached wood fragments accurately. It is essential to proceed with a meticulous surgical technique to remove the foreign body, as the retained wood cannot be easily visualized against the hypodense background due to postoperative brain changes. Regarding MRI, Specht et al., claimed that it helps to identify small wood fragments, mainly in the periorbital region, where it can be confused with adipose tissue, presenting a low-density image.

Wood has low attenuation coefficients, and the appropriate cranial CT scan should include various window settings to allow an accurate assessment of detached wood fragments.

Finally, we showed that the trauma mechanism involved in this report has not been described so far and it is different from the main epidemiologically described trauma mechanisms (interpersonal violence and traffic accidents).
Table 1. Papers published on TBI caused by wood.

| Author                        | Clinical case                                                                 | Research / intervention / outcome                                                                 |
|-------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Al Mulla et al.               | Teenager hit by a splinter of wood in the temporal bone region, caused by exploding fireworks. | n.a.                                                                                               |
| Ishikawa et al.               | A 4-year-old boy presented with a chopstick penetration into the cerebellum through the temporal squamous and tentorium cerebellum, resulting in a cerebellar abscess 1.5 years after the injury. Stair fall and wound in the left preauricular region. | Asymptomatic. Skull X-ray, Skull CT / MRI Skull; Surgery 1: Suboccipital craniotomy with an attempt to locate the bone fragment by ultrasound. Failure and need for surgical re-approach. Surgery 2: Supracerebellar infratentorial suboccipital craniotomy. Minimal ataxia and dysmetria after three weeks. |
| Nishio et al.                 | A 13-year-old girl had a fall with a penetrating wound in the right upper eyelid caused by a piece of wood. She evolved with fragment accommodation and abscess formation seven years after the initial event. | Fever and headache. CT Skull / MRI Skull. Craniotomy with abscess drainage. Favorable and without neurological sequelae. Late complication. |
| Miller et al.                 | Review of 42 cases of orbital drilling by a wooden object.                     | Intracranial suppuration was the main complication, with brain abscess occurring in almost half of the cases. Mortality occurred in 25% of the 28 cases in the post-antibiotic era. |
| Wen et al.                    | Intracranial foreign body misdiagnosis: non-detailed investigation of the patient's admission history. | Poor image of the wooden foreign body by CT scan. Detailed knowledge of the cause of the injury and thorough examination of wounds is crucial to avoid misdiagnosis. |
| McKinlay and Smith            | Penetrating head trauma caused by blast fragmentation.                        | The patient had an Injury Severity Score (ISS) of 75 points. Survival cannot be predicted from the ISS, the rate of penetrating injury, or the presentation of the Glasgow Coma Scale (GCS) alone. |
| Fujimoto et al.               | Case 1: male, 50 years old; bicycle fall after drinking alcohol. On admission, the wooden foreign body was not detected in appearance. | CT scan showed an area of low density similar to air in the bilateral anterior horn of the lateral ventricle. Initial conservative management for traumatic pneumocephalus. Subsequently, it was noticed he was injured by a foreign body penetrating the contralateral frontal lobe through the left nasal cavity. Endonasal extraction by an otolaryngologist, fortunately without problems. The foreign body was a tree branch. |
|                              | Case 2: 18-year-old man suffered a car accident, being hit with a wooden stake penetrating his left eye. | Radiography and tomography of the skull. Clinical. Bifrontal craniotomy with the removal of wood and bone fragments |
|                              | Case 3: 61-year-old man; accident cutting wood with a chainsaw, fragment of wood hit and punctured his right eye. | Radiography and tomography of the skull. Clinical. Right frontotemporal craniotomy. Surgical removal of the piece of wood and other bone and glass fragments |
| Vlková et al.                 | Orbitocerebral wood lesion, size 66 x 7.5 mm, penetrated through the upper eyelid opening in the middle cranial fossa. | Extraction was performed by inferior nasal orbitotomy. |
| Kaiser et al.                 | Pencil penetration of the right temporal lobe through the temporal bone;        | Wood has low attenuation coefficients on cranial tomography. Need for meticulous surgical technique in removing the foreign body. |
| Yano et al.                   | Intracranial wood fragment by penetration through the frontal bone.            | n.a.                                                                                               |
| Specht et al.                 | Traumatic injury to the right eye from a wooden golf club accident.            | Right paranasal laceration; skull CT was performed; it was not possible to visualize the wood fragment, probably due to the overlap with the pericocular fat. MRI showed the wood fragment with a hypodense image. The patient evolved with wound infection and ocular enucleation. |

n.a. = not applied.
Conclusion

Literature findings of intracerebral injury with a wooden object showed that infectious and late neurological manifestations are common due to misdiagnosis. When “linear pneumocephalus” is present, this type of lesion must be suspected, especially if an entry point is in the orbit or the temporal region.

References

1. Magalhães A, Cruz de Souza L, Faleiro R, Teixeira A, Miranda A. Epidemiologia do traumatismo craniocéfálico no Brasil. Rev Bras Neurol. 2017;53:2.
2. Kent Werner J Jr. Management of penetrating brain injury. In: Schmidek HH, Roberts DW, editors. Schmidek and Sweet: operative neurosurgical techniques. 6th ed. Philadelphia: Saunders/Elsevier; 2012. chap. 142, 2.350 p. (2 vol.).
3. Miller CF, Brodkey JS, Colombi BJ. The danger of intracranial wood. Surg Neurol. 1977;7(2):95-103. PMID:835079.
4. Ildan F, Bağdatoğlu H, Boyar B, Doğanay M, Cetinalp E, Karadayi A. The nonsurgical management of a penetrating orbitocranial injury reaching the brain stem: case report. J Trauma. 1994;36(1):116-8. http://dx.doi.org/10.1097/00005373-199401000-00020. PMID:8295236.
5. Nishio Y, Hayashi N, Hamada H, Hirashima Y, Endo S. A case of delayed brain abscess due to a retained intracranial wooden foreign body: a case report and review of the last 20 years. Acta Neurochir (Wien). 2004;146(8):847-50.; published online June 7, 2004. http://dx.doi.org/10.1007/s00701-004-0283-7. PMID:15254807.
6. Ishikawa E, Meguro K, Yanaka K, et al. Intracerebellar penetrating injury and abscess due to a wooden foreign body: case report. Neurol Med Chir. 2000;40(9):458-62. http://dx.doi.org/10.2176/nmc.40.458. PMID:11021077.
7. Al Mulla A, Purva M, Behbehani A. Fireworks injury: temporal bone penetration and a wooden intra-cranial foreign body. J R Coll Surg Edinb. 2001;46(4):249-51. PMID:11523722.
8. Andereggen L, Beck J. Overlooked piece of wood served as a vector transmitting clostridium perfringens: a case report emphasizing the awareness of gas-forming organisms in posttraumatic pneumocephalus. J Craniofac Surg. 2021;32(5):e485-7. http://dx.doi.org/10.1097/SCS.0000000000004745. PMID:33464773.
9. Wen ZH, Luo SQ, Peng YP, Chen GX, QIST. Misdiagnosis of intracranial foreign body: report of one case. J First Mil Med Univ. 2002;22(1):31.
10. McKinlay J, Smith JE. Penetrating brain injury: a case of survival following blast fragmentation injuries to the head. J R Nav Med Serv. 2013;99(2):55-6. http://dx.doi.org/10.1136/jrnsms-99-55. PMID:24079203.

Table 1. Continued...

| Author            | Clinical case                                                                 | Research / intervention / outcome                                                                 |
|-------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Potapov et al.16  | A 26-year-old man suffered TBI from a motorcycle accident.                   | Cranial CT after two months revealed a foreign body in the orbital region penetrating the right temporal lobe, with the development of an abscess around it. Three-dimensional CT allows the choice of the ideal surgical approach and removing the foreign body, avoiding purulent and inflammatory complications. |
| Ildan et al.4     | Perforating trauma of the right orbit by graphite pencil.                    | The wood pierced the subconjunctival in the inner corner of the right eye. It passed through the medial border of the globe and through the superior orbital fissure to the temporal fossa to the lateral face of the sella and posterior clinoid, reaching the brainstem. The entire pencil was removed inch by inch without incident under CT control. |
| Dunn et al.17     | A 53-year-old man suffered facial injury from a horse kick and associated orbital injury. | He evolved with superior orbital fissure syndrome and increased intraocular pressure in the left eye due to a laceration of 5 mm above the margin of the upper eyelid. The image revealed a 3.0 cm x 0.5 cm fragment at the orbital apex with apparent communication with the cranial vault. |
| Andereggen and Beck8 | An elderly patient with a history of TBI from the surgical procedure without removing an intracranial wooden object (tree branch). | The radiological image did not show the fragment. It was evolved with infection and pneumoencephalus by Clostridium perfringens. Brain abscess surgery was performed. |
| Paiva et al.18    | Child with orbit perforation by a bamboo stick.                             | Surgery was done after the patient presented signs of infection.                                  |
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11. Fujimoto S, Onuma T, Amagasa M, Okudaira Y. Three cases of an intracranial wooden foreign body. No Shinkei Geka. 1987;15(7):751-6. PMid:3670545.

12. Viková E, Slapák I, Hrachovina V. Penetration of an orbital foreign body into the intracranial space. Cesk Oftalmol. 1989;45(5):372-4. PMid:2805114.

13. Kaiser MC, Rodesch G, Capesius P. CT in a case of intracranial penetration of a pencil. A case report. Neuroradiology. 1983;24(4):229-31. http://dx.doi.org/10.1007/BF00399777. PMid:6828239.

14. Yano H, Nishimura G, Sakamoto K, Tanaka N, Dazai S, Hirano A. An intracranial wooden foreign body without neurological findings: case report. J Trauma. 1995;38(5):830-2. http://dx.doi.org/10.1097/00005373-199505000-00032. PMid:7760423.

15. Specht CS, Varga JH, Jalali MM, Edelstein JP. Orbitocranial wooden foreign body diagnosed by magnetic resonance imaging. Dry wood can be isodense with air and orbital fat by computed tomography. Surv Ophthalmol. 1992;36(5):341-4. http://dx.doi.org/10.1016/0039-6257(92)90110-F. PMid:1566235.

16. Potapov AA, Eropkin SV, Kornienko VN, et al. Late diagnosis and removal of a large wooden foreign body in the cranio-orbital region. J Craniofac Surg. 1996;7(4):311-4. http://dx.doi.org/10.1097/00001665-199607000-00012. PMid:9133838.

17. Dunn IF, Kim DH, Rubin PA, Blinder R, Gates J, Golby AJ. Orbitocranial wooden foreign body: a pre-, intra-, and postoperative chronicle: case report. Neurosurgery. 2009;65(2):E383-4, discussion E384. http://dx.doi.org/10.1227/01.NEU.0000347474.69080.A1. PMid:19625895.

18. Paiva, Monaco, Soares, Amorim, Andrade, Teixeira. Surgical treatment of a transorbital penetrating brain injury. Clin Ophthalmol. 2010;4:1103-5. http://dx.doi.org/10.2147/OPTH.S9638. PMid:20957055.

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