Case Report

ANNALS OF MEDICINE & SURGERY

OPEN

Penetrating brain injury through the cavernous sinus by chopsticks in Vienamese: a case report

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Introduction and importance: Penetrating brain injuries from chopsticks are exceedingly rare, often documented through case reports. Management strategies are tailored to individual cases, with a focus on mitigating postoperative complications.
Case presentation: A 33-year-old male presented with a chopstick lodged in his right eye. Computed tomography (CT) imaging revealed two foreign bodies, prompting collaborative surgical removal by neurosurgery and ophthalmology teams. The procedure involved intricate bone drilling to access critical structures, ensuring a successful outcome with stability at 1-month follow-up.
Clinical discussion: Common trajectories involve orbital roof penetration, posing risks of frontal lobe injury and intracerebral hematoma. Challenges arise with wooden foreign bodies, necessitating advanced imaging like CT angiography to assess vascular involvement. Surgical intervention offers benefits such as foreign body extraction, neurovascular protection, tissue debridement, hematoma evacuation, and dural repair.
Conclusion: Although rare, chopstick-related penetrating brain injuries warrant vigilance in neurosurgical practice. Surgical intervention remains the cornerstone of treatment, ensuring optimal patient outcomes.

Keywords: cavernous sinus, chopsticks, foreign bodies, orbital roof, penetrating brain injury

Introduction

Penetrating brain injuries caused by foreign bodies are relatively uncommon. In terms of etiology, it can be categorized as high-velocity objects like handguns, hunting rifles, and low-velocity objects with a sharp edge like a knife, chopsticks, stones, scissors, arrows, etc…[1].

Penetrating brain injuries caused by chopsticks are very rare, with the majority of studies comprising case reports. Therefore a standardized protocol for such injuries is lacking and the treatment depends on each particular patient. The decision to remove the foreign object or not is subject to debate due to many complications such as infections, seizures, cerebral vessel damage, cerebrospinal fluid leakage, etc.[2]. The approach is individualized based on each lesion, and preventing complications after surgery is also a significant concern.

In this article, we reported one case of penetrating brain injury caused by a pair of chopsticks, was treated successfully by surgery.

This case report follow the Surgical Case Report (SCARE) guidelines[3].

HIGHLIGHTS

- The severity of injury from penetrating foreign bodies is primarily determined by velocity and trajectory, with implications for tissue damage and prognosis.
- Wooden foreign bodies pose challenges in detection due to variable computed tomography (CT) values over time caused by water absorption, necessitating careful consideration in diagnostic imaging.
- Surgical intervention for penetrating brain injuries offers critical advantages, including foreign body removal, protection of neurovascular structures, and tissue debridement, contributing to improved patient outcomes.

Case presentation

The 33-year-old male was admitted to the hospital with swelling and loss of vision in the right eye. According to the patient, 2 days before, when he was at a party with his friends, one of them was joking and hit his eye with a pair of chopsticks, he waved his hand and broke the chopsticks so one part of the chopsticks was inside his right eye. After that, he lost vision in the right eye and was admitted to a local hospital. He was received intravenous saline,

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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Annals of Medicine & Surgery (2024) 86:5561–5566

Received 13 May 2024; Accepted 6 July 2024

Published online 17 July 2024

http://dx.doi.org/10.1097/MS9.0000000000002389

analgesic, and antibiotics at the local hospital, which is about 400 km from our hospital. During transportation, the patient is fully awake.

On clinical examination, glasgow comma scale was 15/15. The right eye was swollen, ptosis, lost vision, the pupil was dilation, and loss of reflex. The vision and pupil in the left eye were normal. He had a mild headache, the heart rate was 90 bpm, his blood pressure was 130/80 mm Hg and his temperature was 36.5, and no sign of meningitis. The muscle strength on both sides was 5/5 and no neurological deficit. Other organs have not detected coordinated lesions.

The patient underwent a non-contrast computed tomography (CT) scan, which revealed two foreign bodies in the right superior orbital fissure (Fig. 1). The patient's digital subtraction angiography (DSA) images did not show any cerebral vascular injuries (Fig. 2).

Hospitalization: The patient was given anti-tetanus serum, prophylactic antibiotic, analgesic, and saline intravenous.

The patient was taken to the operating room to remove the chopsticks, conducted jointly by members of the neurosurgery and ophthalmology departments (Fig. 3). During the operation, an orbital-zygomatic approach was performed. Then we drill and remove the lesser and greater wing of the right sphenoid bone, the right anterior clinoid process (ACP), reveal the right superior orbital fissure (SOF), and optic canal, and release the roof of the orbital and the lateral wall of the cavernous sinus. After that, the tips of two chopsticks were exposed and removed one by one carefully. There was some bleeding from the cavernous sinus after we removed the second chopstick and the Surgicel was used for hemostasis. The postoperative course was uncomplicated. Antibiotics were given until he was discharged 10 days after the operation.

The follow-up after 1 month, he was stable in both clinic and imaging.

Discussion

Mechanism of injury

The most important determinants of the severity of injury from these penetrating foreign bodies are velocity and trajectory[4]. Penetrating brain injury by a foreign body can be divided into two categories: high-velocity objects and low-velocity objects[1]. High-velocity objects are sharp bullets that have impact velocities greater than 120 m/s and are associated with shock waves, cavitation, causing damage with thermal and kinetic injuries, which carry a high incidence of morbidity and mortality. Low-velocity objects such as knives, scissors, chopsticks, screws, metallic rods, arrows, etc., typically penetrate through areas of thinned bone such as the temporal bone, skull base, and orbit. Consequently, the pathophysiology involves laceration and maceration of the tissues, which is restricted to the wound without the surrounding blast effect; therefore, the prognosis is better[1,5,6].

Pathology

With the transorbital penetrating brain injury by a low-velocity object, due to the shape of a horizontal pyramid on a posteromedially directed axis of the orbit, which tends to deflect objects toward the apex, and the naturally occurring SOF, inferior orbital fissure, and optic canal serve as passageways to the cranial cavity[7,8]. However, in reality, there are two major trajectories by which foreign bodies penetrate intracranially. The most common trajectory is via the orbital roof, which has thin bone and therefore offers little resistance, causing damage to the frontal lobe and intracerebral hematoma. However, the prognosis for this type of injury is not so poor because we can easily remove the hematoma and the foreign body. The second common trajectory is through the SOF, which routes provide direct access without bone fracture, whereby foreign bodies can reach the brainstem through the cavernous sinus and can cause critical intracranial complications such as internal carotid artery (ICA) injury, carotid-cavernous fistula, damage to cranial nerve and brainstem[4,7–10]. The rate of vascular complications after penetrating brain injuries ranges from 5 to 40% in the literature[1]. Of all vascular injuries associated with PBI, traumatic intracranial aneurysms are the most common (39%), followed by arterial dissections (29%), arterial occlusion (21%), and arterio-venous fistulas (11%). Approximately 96% of the injuries are limited to the anterior circulation, namely the middle carotid artery (MCA) and ICA[2]. In our cases, the foreign bodies caused the complete occlusion of the left ICA, luckily the collateral blood flow was adequate so the patient had no paralysis. Especially, the globe is not damaged even if the foreign body's trajectory passes through the orbit[4,7]. According to Turbin and colleagues: the globe is often pushed aside as the foreign body traverses the orbit, allowing exit of the foreign body through the orbital roof or via the OC or SOF[7], as the same as our case report.

The route of the foreign body through the orbital into the cranial vault can cause many complications. They include visual pathway injuries, cranial nerve injury, intracerebral contusions/ hematomas, seizures (30–50%), vascular injury (38–50%) such as traumatic intracranial aneurysms (39%), arterial dissections (29%), arterial occlusion (21%) and arterio-venous fistulas (11%), CSF leakage, infections in the form of meningitis (64–70%) and brain abscess (48–52%)[2,5,8,9,11] In our case, because the trajectory of the chopsticks is through the cavernous sinus and very close to the right ICA, the DSA was performed so we can use endovascular techniques immediately if there is a sign of arterial hemorrhage, dissection, or carotid-cavernous fistula. There were no parenchymal contusions or hematoma in our case, the patient had no sign of seizures so we did not use anti-seizure prophylaxis. According to the literature, the infection rate is very high and our patient was admitted to our hospital after two days, so he has a very high risk of infection, and antibiotic prophylaxis is very important.

Diagnostic imaging

CT scanning of the head is now the primary modality used in the neuroradiologic evaluation of patients with PBI[11]. CT is advantageous over other imaging modalities as readily available, quickly performing, and provides lots of useful information such as the skull fractures, intracranial injuries, the trajectory of FB, and the relationship between the penetrating object and intracranial anatomical structures[5,11,12]. Multilayer CT image three-dimensional reconstruction (3D-CT) can fully display the nature, size, length, direction, and position of intracranial foreign objects in different angles, which is beneficial for surgeons to make an optimal operation plan[5]. The CT can easily detect metallic foreign bodies but with the wooden foreign bodies, due to

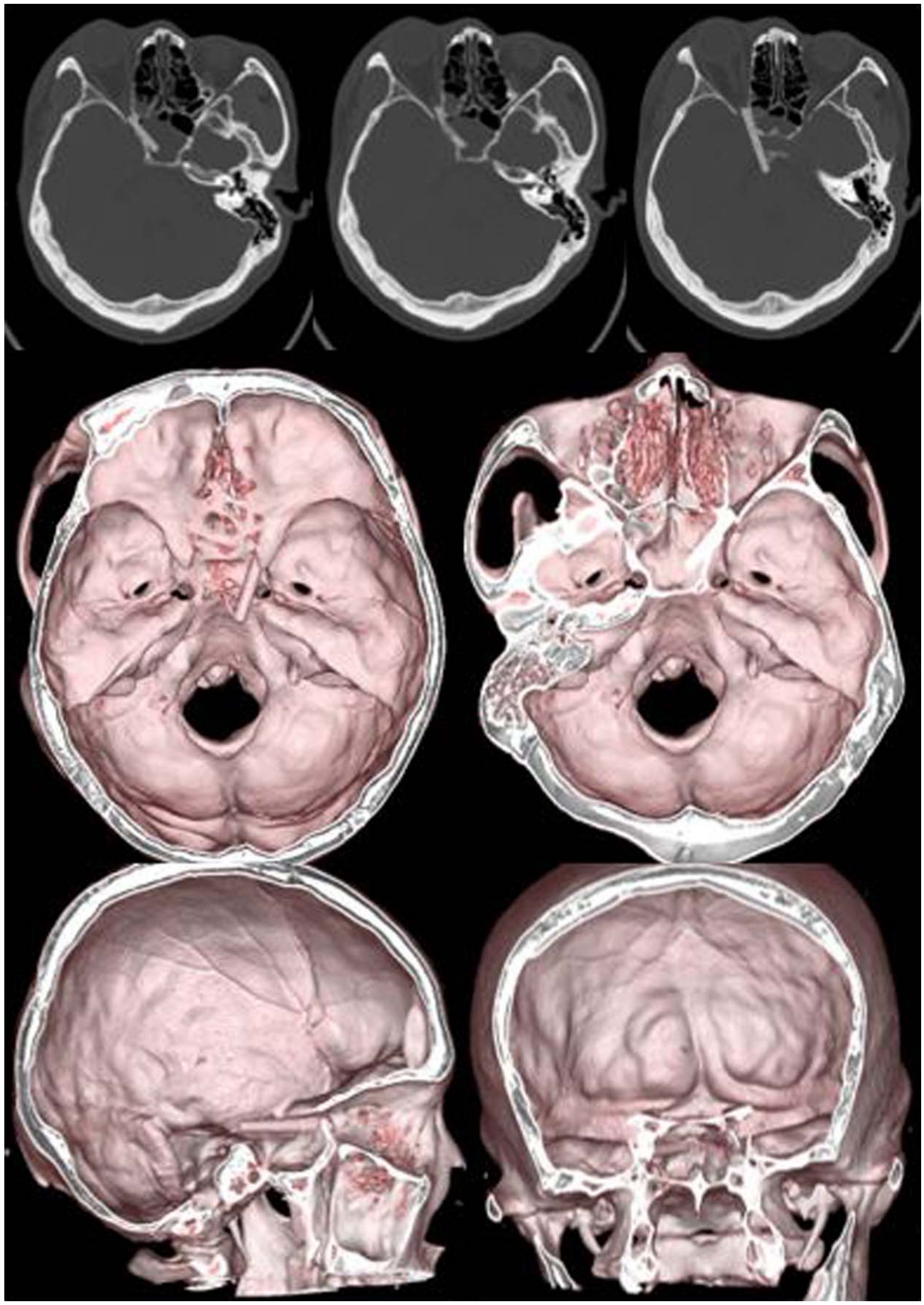

Figure 1. A non-contrast computed tomography (CT) scanner showed the image of a liner hyperdensity structure extending from the right superior orbital fissure (SOF), that's suggesting a foreign body. From a CT scan with 3-dimensional reconstruction, we were able to observe two foreign bodies: the first is through the sphenoid sinus and the second is through the cavernous sinus and terminal at the posterior fossa.

absorption of the surrounding water, the CT value is varied with time[9]. According to Hansen and colleagues, many organic foreign bodies have densities very close to the intracranial and orbital soft tissues[13]. Dry wood can have a low Hounsfield (HU) density on CT and, after soaking in water, depending on hydration, wood can have a higher HU density[7,8,13]. MRI is superior to CT for the detection of wooden and organic foreign bodies but noted that when ferromagnetic foreign bodies are present, MRI should be avoided[2,7,12]. When penetrating brain injuries carry a high suspicion of vascular injury, CT angiography (CTA) or cerebral angiography is recommended[5,9,11,12]. In our case, the chopsticks had been soaked in water intracranial for two days before the patient was admitted to our hospital so in the non-contrast CT scanner, that was hyperdensity and we could easily identify it from the bone, the air, and the brain parenchyma. In 3D-CT, we could have a comprehensive view of the object's

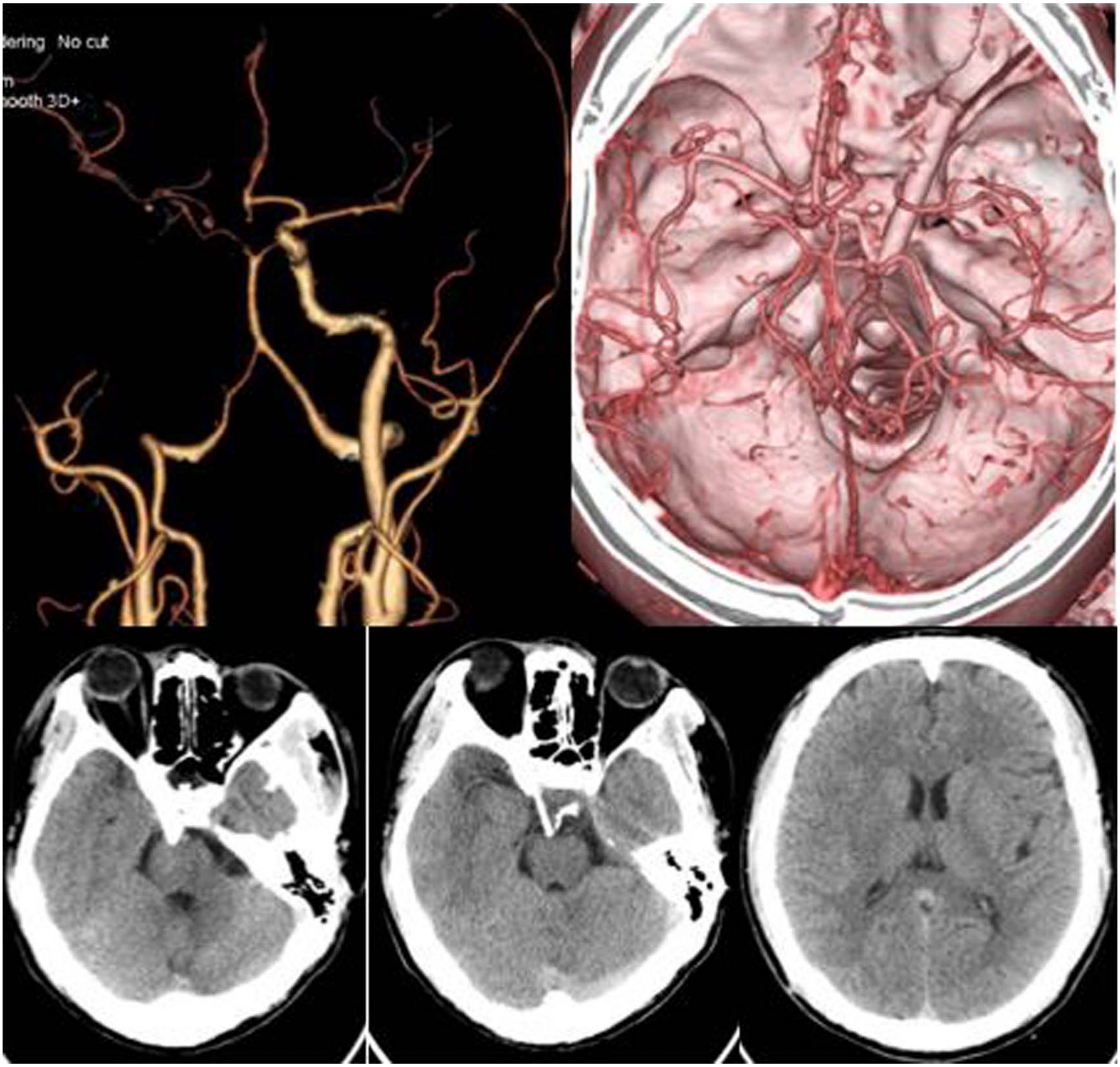

Figure 2. A digital subtraction angiography study showed complete occlusion of the right internal carotid artery. The flow in the right anterior carotid artery and middle carotid artery was normal because of the adequate collateral blood flow. The remaining cerebral vascular was normal.

trajectory and its relation to surrounding structures, which is very important for the optimal operation plan.

Treatment

There is no standardized treatment for penetrating brain injury: when surgery and when conservation. Before treatment, we need to understand sufficiently the mechanism, trajectory, and pathophysiology of injury. The surgical has the advantages of removing foreign bodies, protecting critical neurovascular structures, debridement of necrotic brain tissue, evacuation of the hematoma, and repair of dural defects[5]. In recent, the trend in the management of penetrating brain injuries is minimally invasive in stable patients, which can avoid complications of aggressive surgical debridement of deeply foreign bodies[5,11,14]. In our case, the patient was stable after two days, but the foreign bodies were the wooden chopsticks, one of those is through the sphenoid sinus therefore the risk of infection is very high. According to the literature, wood is especially dangerous because it is soft, organic, porous, contaminated, easily fragmented, and provides a good environment for bacteria[15–17]. Therefore, a retained wooden body in orbit or cranium can cause severe infectious complications days to years after the initial injury. Brain abscess which is the main cause of death occurred in 50% of periorbital penetrating brain injuries and 71% of injuries caused by a pencil[16]. Thus, the complete removal of such a small

Figure 3. The chopsticks were completely removed.

retained wooden body is essential[17]. In our patient, the chopsticks were broken before and we couldn't remove them through the orbital, so we decided to perform a craniotomy. By an orbital-zygomatic craniotomy, we approached the skull base, clearly exposed the chopsticks, and removed both of them.

Conclusion

In summary, penetrating brain injuries caused by foreign bodies, including rare occurrences such as those involving chopsticks, present complex challenges in diagnosis and treatment. With the absence of standardized protocols, decisions regarding surgical intervention must be carefully tailored to each patient's specific condition and potential complications. Our successful treatment of a penetrating brain injury caused by chopsticks underscores the importance of individualized approaches and highlights the need for further research to establish comprehensive guidelines for managing such cases.

Ethical approval

This study was approved by the ethics committee of the institution.

Consent

Written informed consent was obtained from the patient for the publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Source of funding

None.

Author contribution

H,V,D,: visualization, writing—original draft, writing—review and editing. A.H.P.: conceptualization, resources, supervision. H.T.V.: conceptualization, methodology, investigation, writing—original draft, writing—review and editing, visualization. A.Q.N.: visualization, writing—original draft, writing—review and editing. H.H.T.D.: conceptualization, methodology, investigation, writing—review and editing, supervision.

Conflicts of interest disclosure

The authors declares no conflicts of interest.

Research registration unique identifying number (UIN)

This is not an original research project involving human participants in an interventional or an observational study but a case report; this registration was not required.

Guarantor

Anh Hoang Pham.

Data availability statement

All data underlying the results are available as part of the article and no additional source data are required.

Provenance and peer review

Not commissioned, externally peer-reviewed.

References

[1] Zyck S, Toshkezi G, Krishnamurthy S, *et al*. Treatment of penetrating nonmissile traumatic brain injury. Case series and review of the literature. World Neurosurg 2016;91:297–307.
[2] Loggini A, Vasenina VI, Mansour A, *et al*. Management of civilians with penetrating brain injury: a systematic review. J Crit Care 2020;56: 159–66.
[3] Sohrabi C, Mathew G, Maria N, *et al*. The SCARE 2023 guideline: updating consensus Surgical CAse REport (SCARE) guidelines. Int J Surg 2023;109:1136–40.
[4] Ghadersohi S, Ference EH, Detwiller K, *et al*. Presentation, workup, and management of penetrating transorbital and transnasal injuries: a case report and systematic review. Am J Rhinol Allergy 2017;31:e29–34.
[5] Li XS, Yan J, Liu C, *et al*. Nonmissile penetrating head injuries: surgical management and review of the literature. World Neurosurg 2017;98: 873.e9–25.
[6] Sweeney JM, Lebovitz JJ, Eller JL, *et al*. Management of nonmissile penetrating brain injuries: a description of three cases and review of the literature. Skull Base Rep 2011;1:039–46.
[7] Turbin RE, Maxwell DN, Langer PD, *et al*. Patterns of transorbital intracranial injury: a review and comparison of occult and non-occult cases. Surv Ophthalmol 2006;51:449–60.
[8] Shin TH, Kim JH, Kwak KW, *et al*. Transorbital penetrating intracranial injury by a chopstick. J Korean Neurosurg Soc 2012;52:414.
[9] Mzimbiri JM, Li J, Bajawi MA, *et al*. Orbitocranial low-velocity penetrating injury: a personal experience, case series, review of the literature, and proposed management plan. World Neurosurg 2016;87:26–34.
[10] Kasamo S, Asakura T, Kusumoto K, *et al*. Transorbital penetrating brain injury. No Shinkei Geka Neurol Surg 1992;20:433–8.
[11] Kazim SF, Shamim MS, Tahir MZ, *et al*. Management of penetrating brain injury. J Emerg Trauma Shock 2011;4:395.

[12] Temple N, Donald C, Skora A, *et al*. Neuroimaging in adult penetrating brain injury: a guide for radiographers. J Med Radiat Sci 2015;62: 122–31.
[13] Hansen JE, Gudeman SK, Holgate RC, *et al*. Penetrating intracranial wood wounds: clinical limitations of computerized tomography. J Neurosurg 1988;68:752–6.
[14] Abdelhameid AK, Saro A. Non-missile penetrating brain injuries: cases registry in Sohag University Hospital. Egyptian J Neurosurg 2019;34:1–9.
[15] Miller CF, Brodkey JS, Colombi BJ. The danger of intracranial wood. Surg Neurol 1977;7:95–103.
[16] Maruya J, Yamamoto K, Wakai M, *et al*. Brain abscess following transorbital penetrating injury due to bamboo fragments—case report—. Neurol Med Chir (Tokyo) 2002;42:143–6.
[17] Ginsberg LE, Williams D 3rd, Mathews VP. CT in penetrating craniocervical injury by wooden foreign bodies: reminder of a pitfall. AJNR Am J Neuroradiol 1993;14:892–5.