CASE REPORT

UNUSUAL CASE OF A METAL FOREIGN OBJECT IN ORBITOCRANIAL INJURY: UNLOCKING THE MACCARTY KEYHOLE

Fadiah Gazzani Rahman[1], Andi Pratiwi[1], Halimah Pagarra[1], Suliati P. Amir[1]
[1]Department of Ophthalmology, Faculty of Medicine, Hasanuddin University
Email: fadiahgazzani@gmail.com

ABSTRACT

***Introduction**: Penetrating orbitocranial injuries are quite rare but very fatal if left untreated. Various metal objects have been reported as foreign bodies that have penetrated the orbit. However, unusual objects such as motorcycle locks have never been reported before.*

***Case Illustration:** A 14-year-old boy was brought to the emergency room with a motorcycle lock embedded in his left temporal region. Examination of the left eye showed decreased vision, clear serous ciliary secretions, conjunctival hyperemia, chemosis, and relative afferent pupillary defect. Investigations using a 3D Head MSCT Scan revealed the presence of a metal object that penetrates the left optic nerve, the rectus lateralis muscle, and the frontal process of the left zygoma bone in the left temporal region, which is located around the MacCarty keyhole. The operation in the form of exploration and foreign object removal was then carried out in collaboration with the neurosurgeon. No postoperative complications were reported, but the patient had restricted movement of the left eye.*

***Discussion:** Penetrating orbitocranial injury should be treated as an emergency. Diagnosis should include comprehensive ophthalmological and neurological examinations. CT Scan continues to be the best cranial imaging technique. In this case, the motorcycle lock penetration was around the MacCarty keyhole, a structure that is frequently used to enter both the orbit and the frontal fossa, which located 7 mm superior and 5 mm posterior to the frontozygomatic suture. An appropriate surgical strategy is mandatory for removing the object because it may lead to serious consequences, including cerebral, infectious, vascular complications, and even death.*

***Conclusion**: Metal foreign objects such as motorcycle lock was considered unusual, particulary when it unlock an important landmark such as MacCarty keyhole. This case emphasizes the significance of a surgical strategy based on accurate anatomical tracking.*

***Keywords:** penetrating orbitocranial injury, unusual foreign objects, motorcycle lock, MacCarty keyhole.*

INTRODUCTION

Injuries to the orbitocranium (orbitocranial injuries) that penetrate the skull account for just 0.4% of all head injuries in the general population, yet they are extremely deadly.[4] Approximately 45% of penetrating head injuries in children and 24% of penetrating head injuries in adults result from these traumas.[5,6] Despite being rare, penetrating orbitocranial injuries frequently result in serious brain damage if left untreated.[7] Additionally, these injuries may result in eyeball abrasions, retrobulbar hematoma, prolapse, injury to the optic nerve (visual abnormalities), intracranial consequences (neurological deficits), vascular complications

(hemorrhage, thrombosis, or occlusion) and infection.[4] The mechanisms by which this type of trauma occurs are falls, motorcycle crashes, accidents, suicides, murder attempts, and explosions.[6,8] Knives, nails, spikes, iron rods, pencils, scissors, fan blades, and screwdrivers are examples of foreign objects that can result in stab wounds that penetrate the orbit and skull.[5,7]

Lacerations from trauma should be examined since they may contain foreign objects.[8] Penetrating orbitocranial injuries might have pronounced clinical signs when they present.[6] Large penetrating object needs specialized care given as soon as possible.[10] The removal of foreign objects in penetrating orbitocranial injuries may increase the risk of further neural, vascular, and cerebral damage. Therefore, surgical therapy strategies may be considered according to the location, type, and size of the traumatic agent.[6] The most common route of foreign objects entry is through the superior orbital roof due to its thin structure and the fragility of the superior orbital plate of the frontal bone in the anterior cranial fossa floor. Another route that relatively common reported is through the superior orbital fissure due to its conical shape, inferior orbital fissure, and optic canal.[9,17,18] Herein, we report a case of penetrating orbitocranial injury in a 14-year-old boy which was caused by a motorcycle lock located right at the keyhole which is very rare where in the last 10 years there have been no similar cases reported in the literature.

CASE ILLUSTRATION

A 14-year-old boy was brought to the emergency room after being stabbed with a motorcycle lock that was embedded to his left temporal region (Figure 1A, 1B). The patient complained of pain and blurring in the left eye accompanied by red and watery eyes since the incident.

Figure 1. Clinical photograph of the patient showing a motorcycle lock embedded in the left temporal region (A,B) with proptosis, chemosis, and hyperemia of the conjunctiva (C).

Airway, breathing, and circulation were within normal limits. An examination of the left eye revealed the visual acuity was 20/40 with normal intraocular pressure. There was lagophthalmos, hyperemia and chemosis of the conjunctiva with minimal clear serous discharge, and mild relative afferent pupillary defect (Figure 1C). The remaining structures were normal. Examination of the right eye revealed no abnormalities.

Supporting examination in the form of a 3D Head MSCT Scan was performed, which revealed the presence of metal density (foreign object) from the frontal process of the left zygoma bone to the posterior of the orbital cavity, with a depth of ± 5cm from the skin, which penetrates the frontal process of the left zygoma bone, the rectus lateralis muscle, and the left optic nerve (Figure 2, Figure 3). There was also fracture of the frontal process of the left zygoma; beam hardening (metal artifact) in the left temporal region; and retention cyst of the right maxillary sinus and left sphenoid sinus. It appeared that the trauma has an impact on an anatomical structure known as the MacCarty keyhole (Figure 3).

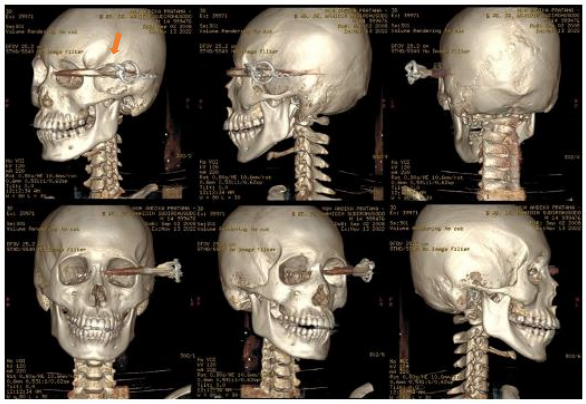

Figure 2. Head MSCT Scan (without contrast) examination showing a metal artifact in the left temporal region

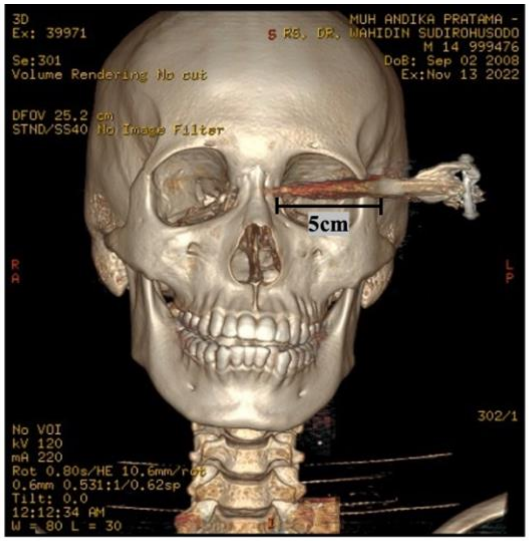

Figure 3. The metal density from the frontal process of the left zygoma bone to the posterior of the orbital cavity, with a depth of ± 5cm from the skin

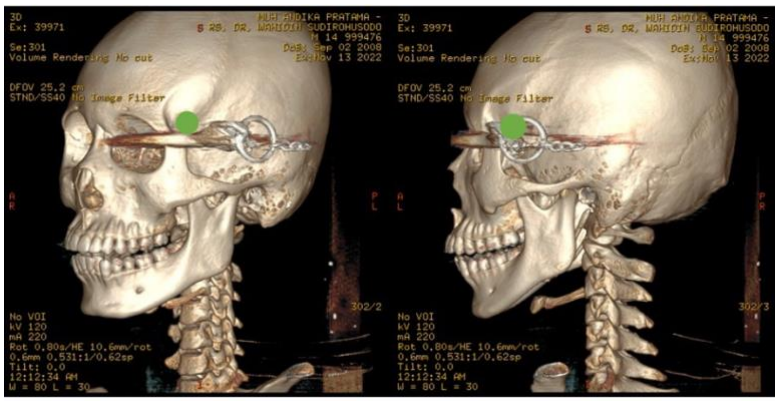

Figure 4. The foreign object impact the MacCarty keyhole (green circle)

The laboratory examination results showed leukocytosis. The diagnosis of penetrating trauma in the left temporal region with orbital involvement was made. The patient was given intravenous Ceftriaxone 1 gram per 12 hours, Metamizole 1 gram per 8 hours, and Ranitidine 50 milligrams per 12 hours.

Exploration and removal of the foreign object was performed in collaboration with neurosurgeon. A lazy S incision is made parallel to the zygoma through the insertion point of the foreign object and deepened, penetrate the cranium. A temporal conjunctival peritomy was made, the tenon was released, then the lateral rectus muscle identified and fixated with 5.0 non absorbable suture. The neurosurgeon then performed craniotomy to remove the foreign object from the lateral wall of the orbital cavity. Forced duction test was done to evaluate the extraocular muscle's function and revealed no restriction at any directions. Evaluation of orbital cavity was normal. The lateral rectus fixation was removed, and conjunctival suture was performed with 8.0 absorbable suture.

The patient was given Polygran eye ointment three times daily, Posop eye drop four times daily, eye compress with Vasacon eye drop four times daily, and oral Methylprednisolone 8mg three times daily.

After surgery, the visual acuity of the left eye decreases to 20/60, there was swelling and hematoma of the eyelid (Figure 5). Examination of the eye movement showed restriction to the superotemporal, temporal, and inferotemporal direction, with interpretation -2, -1, and -2, respectively (Figure 6). The lagophthalmos and relative afferent pupillary defect persisted. The patient was referred to Neuro-ophthalmology division. However, the patient refused funduscopy examination so the optic nerve could not be evaluated and refused the high-dose steroid therapy.

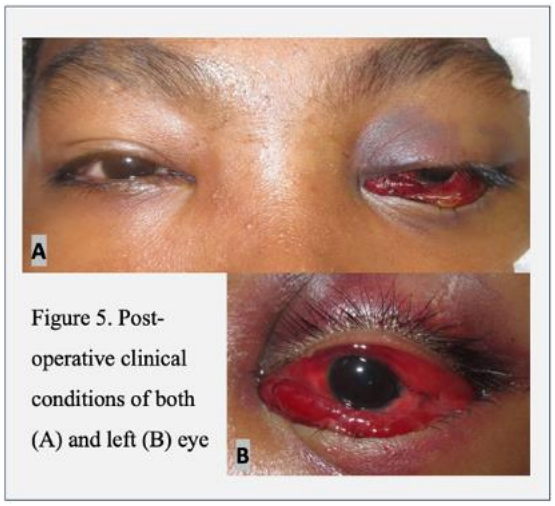

Figure 5. Post-operative clinical conditions of both (A) and left (B) eye

Figure 6. Evaluation of eye movements post-operatively

DISCUSSION

The orbit is a bony cavity that resembles a quadrangular pyramid, with the base located in front and the apex in the back. This anatomical feature has the ability to deflect objects in the direction of the apex, where the superior orbital fissure and optic canal serve as access points to the skull. Additionally, the frontal bone's thin plate and the lesser wing of the sphenoid that make up the roof of the orbit are both easily fractured.[13] The MacCarty keyhole (Figure 7), which is drilled 1 cm behind the frontozygomatic junction (between the zygomatic process of the frontal bone and the frontal process of the zygomatic bone), as the first connecting point between all orbital cuts of the roof and the lateral wall.[20] Tubbs et al. (2010) concluded that the most precise placement of the MacCarty keyhole was at a location approximately 7 mm superior and 5 mm posterior to the frontozygomatic suture.[12]

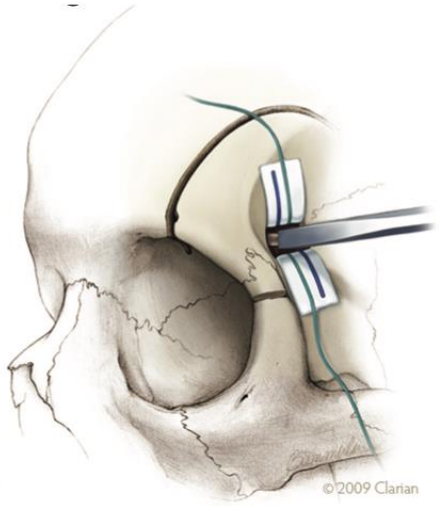

Figure 7. The site of MacCarty keyhole[12]

The MacCarty keyhole and the surgical anatomy of the inferior orbital fissure must be understood to perform a frontotemporal orbitozygomatic approach safely and successfully. Additionally, making use of the MacCarty burr hole aids in maintaining the orbit's lateral wall, which is crucial for avoiding postoperative enophthalmos.[11,20] Accordingly, we accounted this structure when choosing the surgical procedures on patient.

A literature review by Amaral et al. (2020) involving 33 cases with penetrating orbital trauma between 1997 to 2018 reported the main cause for the orbital penetration by foreign objects was assaults (36.3%), followed by falling over blunt objects (33.3%), and motor vehicle accident (12.1%).[8] In our case, the cause of the penetration of the foreign object was an assault.

According to reports, this case accounts for 24% of in adults and 45% in children, and it affects boys more frequently than girls.[11] This was evident in our case, where the patient is a boy.

Prior cases have reported unusual foreign objects like house key (Sarkar et al., 2015) and pressure cookers nozzle (Bhattacharyya et al., 2022) causing penetrating ocular injuries.[9,14] In our case, the foreign object was a motorcycle lock. To the best of our knowledge, we considered this report as a rare and unusual case.

The diagnosis was based on physical examination where there was evidence of lagophthalmos, hyperemia and chemosis of the conjunctiva, clear serous discharge, and the presence of relative afferent pupillary defect, indicating involvement of orbital structures. These findings were classically similar with previous studies. Yin et al. (2020) reported a 66-year-old male patient with a coat hook penetrated his left orbit through the lower lid. The ophthalmologic exam revealed an edematous left lower eyelid, decreased visual acuity, and relative afferent pupillary defect.[16] Hansen et al. (2020) described a 75-year-old man with left upper cheek laceration with a lodged wooden object. The examination revealed periorbital swelling, blepharoptosis, conjunctival hyperemia, exophthalmos, and relative afferent pupillary defect.[19]

Radiographic studies are crucial for making a proper diagnosis, selecting an appropriate surgical protocol, and determining the size, shape, and trajectory of the foreign object penetration.[15,16] The use of simple facial X-rays for the identification of orbital fractures is debatable in specific situations where there is a possibility of an intraocular foreign body.[10,16] This is particularly true in our case because the foreign object can be seen clearly and the mechanism of injury can be foreseen, eliminating the need for a plain x-ray. Complaints of blurred vision and limited eye movement raise our suspicions of damage to the orbital structures and optic nerve. Because of the metallic property of the foreign object, we chose to perform a 3D Head MSCT Scan to determine the impacted orbitocranial structures and severity of the

injury, which is also the gold standard test for penetrating orbitocranial injury.[10,11,13,16]

In our case, the penetration of the foreign object was through the frontal process of the left zygoma bone and the CT scan revealed the wound is located around the MacCarty keyhole. This structure is regarded as the foundation of orbitozygomatic approaches, which were used in our case and are frequently employed by skull base neurosurgeons.

Additional laboratory tests for preoperative evaluation were performed with results of leucocytosis. According to the literature, broad-spectrum antibiotics with good central nervous system penetration, such as metronidazole, ciprofloxacin, and ceftriaxone, should be administered as soon as possible after admission to begin treatment. Although the visual outcome has not been established, high dose steroids are recommended for traumatic optic neuropathy.[10] In our case, the administration of high dose steroids was not done because the patient refused to undergo funduscopy examination causing the optic nerve could not be evaluated.

Penetrating orbitocranial injury patients are at a high risk for intracranial infections. Brain abscess, encephalitis, meningitis, osteomyelitis, and scalp wound sepsis can happen. Monitoring infection indicators and prompt prophylactic antibiotic administration for 7 to 14 days are advised.[16] In our case, the patient showed no symptoms of infection or vascular complications, which may have been prevented by the rapid and accurate removal of the foreign object during surgery. However, signs of eye disorders caused by lockkey trauma to the surrounding muscles, nerves, or directly to the eye organs persist after surgery. A long-term follow up is mandatory. Nevertheless, our patient had a poor compliance which limited us in assessing long-term outcomes.

CONCLUSION

Penetrating orbitocranial injury cases caused by unusual foreign objects such as motorcycle lock are uncommon. In such cases, suspicion of involvement of the orbital structures should be tracked with a 3D CT-Scan. The clinical outcome is strongly influenced by the object's entry point, trajectory, involvement of the paranasal sinuses, degree of brain parenchymal injury, and complications. This case emphasizes the significance of a surgical strategy based on accurate anatomical tracking.

REFERENCES

1. D'Antone V, Flórez DCP, García CJL, Manrique FDMC, Barbosa NL. Epidemiological findings of childhood ocular trauma in a public hospital in Colombia. BMC Ophthalmol. 2021;21(1):1–7.
2. Yüksel H, Türkcü FM, Çinar Y, Cingü AK, Şahin A, Şahin M, et al. Etiology and prognosis of penetrating eye injuries in geriatric patients in the Southeastern region of Anatolia Turkey. Ulus Travma ve Acil Cerrahi Derg. 2014;20(4):253–7.
3. Dogramaci M, Erdur SK, Senturk F. Standardized classification of mechanical ocular injuries, efficacy, and shortfalls. Beyoglu Eye J. 2021;6(3):236–42.
4. Klančnik M, Ivanišević P, Lupi-Ferandin S, Sučić A, Ledenko V, Lešin M, et al. Penetrating orbitocranial injury. Acta Clin Croat. 2018;57(4):792–6.
5. Agrawal A, Reddy VU, Kumar SS, Hegde K V., Rao GM. Transorbital Orbitocranial Penetrating Injury with an Iron Rod. Craniomaxillofac Trauma Reconstr. 2016;9(2):145–8.
6. Rzaev DA, Danilin VE, Letyagin G V., Istomina TK, Chishchina N V. Penetrating orbitocranial injury: A review of the literature and a case report of injury by a watercolor brush in a 3-year-old child. Zhurnal Vopr Nejrokhirurgii Im NN Burdenko. 2017;81(2):77–87.
7. Ahn SS, Song YJ, Kim KU. Penetrating Orbitocranial Metallic Foreign Body Injury - A Case Report -. J Korean Neurotraumatol Soc. 2009;5(2):103.
8. Amaral MBF, Costa SM, de Araújo VO, Medeiros F, Silveira RL. Penetrating Orbital Trauma by Large Foreign Body: Case Series Study with Treatment Guidelines and Literature Review. J Maxillofac Oral Surg. 2023;22(1):39–45.
9. Sarkar S, Modi S, Seth AK, Panja S. An Unusual Transorbital Penetrating Injury by House-key (lock): A Case Report with a Small Review of Literature. 2Journal Clin Diagnostic Res. 2015;9(9):08–9.
10. Diciano Jr. MD DG, Suzanne Sabundayo-Tiu MD, Elaine Yatco-Omaña MD. A Case of an Orbitocranial Injury with an Unusual Foreign Object. J Ophthalmic Sci. 2021;2(3):45–52.
11. Shimizu S, Tanriover N, Rhoton AL, Yoshioka N, Fujii K. MacCarty keyhole and inferior orbital fissure in orbitozygomatic craniotomy. Neurosurgery. 2005;57(1 SUPPL.):152–9.
12. Tubbs RS, Loukas M, Shoja MM, Cohen-Gadol AA. Refined and simplified surgical landmarks for the MacCarty keyhole and orbitozygomatic craniotomy. Neurosurgery. 2010;66(6 Suppl Operative):230–3.
13. Tabibkhooei A, Aslaninia A, Anousha K. Childhood Transorbital Skull Base Penetrating Injury: Report of 2 Cases and Review of Literature. World Neurosurg [Internet]. 2019;131:213–6. Available from: https://doi.org/10.1016/j.wneu.2019.06.234
14. Bhattacharyya M, Soren AJ, Anuradha A, Prakash O. An Unusual Foreign Body from Domestic Ocular Injury. Indian J Ophtalmol [Internet]. 2022;2(3):786–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28331284%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC5354527%5Cnhttp://bmcpsychiatry.biomedcentral.com/articles/10.1186/1471-244X-11-49%5Cnhttp://bmcophthalmol.biomedcentral.com/articles/10.1186/s12886
15. Barouj MD, Tabrizi R, Behnia P, Tabrizi MAA, Kheirkhahi M. Penetrating Orbital Injury; a Case Report and Treatment Algorithm. Arch Acad Emerg Med. 2020;8(1):e33.
16. Yin HY, Dhanireddy S, Braley AE. Management of an Unusual Orbitocranial Penetrating Injury. Case Rep Ophthalmol Med. 2020;2020:1–5.
17. Wu Y, He W, Yang Y, Chen J. A Rare Case of Orbitocranial Penetrating Injury with Intracranial Wooden Foreign Body Residue. Med. 2022;58(12).
18. Wu Y, Chen T, Yuan M, Mzimbiri JM, Liu Z, Chen Y, et al. Orbitocranial Penetrating Injury With Multiple Vessel Invasion in an Infant: A Case Report and Literature Review. Front Neurol. 2020;11(November):1–6.
19. Hansen MLU, Thorsberger M, Jørgensen JS, Von Buchwald C. Penetrating Orbital Sphenoid Sinus Trauma with a Wooden Stick: A Challenging Case Report. Case Rep Ophthalmol. 2020;11(3):540–5.
20. Jumah F, Adeeb N, Dossani RH. Collin S. MacCarty (1915–2003): Inventor of the "MacCarty Keyhole" as the Starting Burr Hole for Orbitozygomatic Craniotomy. World Neurosurg [Internet]. 2018;111:269–74. Available from: https://doi.org/10.1016/j.wneu.2017.12.121
21. Palejwala SK, Skoch J, Lemole GM. Removal of symptomatic craniofacial titanium hardware following craniotomy: Case series and review. Interdiscip Neurosurg Adv Tech Case Manag [Internet]. 2015;2(2):115–9. Available from: http://dx.doi.org/10.1016/j.inat.2015.04.002
22. Luzzi S, Lucifero AG, Spina A, Baldoncini M, Campero A, Elbabaa SK, et al. Cranio-Orbito-Zygomatic Approach: Core Techniques for Tailoring Target Exposure and Surgical Freedom. Brain Sci. 2022;12(3):1–17.