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Case Report

Transorbital subfrontal arrowhead injury: Experience in a low-resource setting

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ABSTRACT

Background: With the insurgency and farmer-herder crisis in northeast Nigeria, arrow injuries with various fatalities have been on the increase. Practicing in a low-resource setting with no functional computed tomography (CT) scan necessitates utmost dependence on plain X-rays for decision-making in patient care.

Case Description: We present our experience with a patient who presented in our facility with a right transorbital subfrontal arrow injury. The patient had retrograde extraction of the arrow based on plain X-ray findings with no sequelae.

Conclusion: We highlighted the role of X-ray in the management of arrow injuries, although bone window CT without or with angiography is the gold standard of imaging modalities in the management of patients with arrow injuries to the head.

Keywords: Arrow injury, Low-resource setting, Subfrontal, Transorbital, X-rays

INTRODUCTION

Arrow injuries, once thought to have gone into extinction with the prehistoric era, are now being seen in modern times both in the developed and developing world, with its rise on the increase in the developing world and especially in northern Nigeria as a result of the insurgence (Boko Haram) and increasingly the farmer-herder crisis.[1,2,15]

Although the injury involves the upper extremities commonly, the head and neck are also affected with increased frequency. The magnitude of the injury is dependent on the distance and tangent of the arrow; hence, an arrow shot at close range (<50 m) and right tangent can pierce through a very strong supraorbital ridge.[4,20] Arrowhead generally tamponades vital vessels; hence, most patients with no major vessel laceration arrive at a health facility alive and managed with little or no sequelae.[12,19]

Plain X-rays had been used in the precomputed tomography (CT) era to manage patients with arrow injuries.[12] However, it is still being used in modern times as the initial imaging modality, in conjunction with bone window CT scan, without or with angiography as determined by the arrowhead location on the X-ray.[19]

The management of arrow injury to the head entails proper resuscitation, wound debridement, extraction of the arrow under direct vision, hematoma evacuation, watertight dural closure, and empirical antibiotics.[19]

CASE REPORT

This is a 50-year-old right-handed male farmer who presented at the emergency department of our facility on account of arrowhead impalement in the right medial canthus and bleeding from the same spot following a farmer-herder altercation. However, there was no vomiting, visual impairment, personality change, seizure, loss of consciousness, or differential limb weakness. At the presentation, he was seen by the ophthalmology team, which involved the neurosurgery team on account of the skull X-ray findings of transorbital-sub-frontal arrowhead impalement with sub-frontal aerocele, sparing the globe. The arrowhead was just lateral to the right frontal sinus [Figures 1a-c]. On evaluation, he had normal vital signs, conscious, and alert, with normal mental status. He had no signs of raised intracranial pressure, visual impairment, or sensorimotor deficit. He had a snuggly hanging 20 cm arrow, just 1 cm lateral to the right medial canthus, with crusted blood around the arrowhead and the right side of the nose and no cerebrospinal fluid (CSF) leak as seen in Figure 1a. A craniofacial CT scan could not be done since the one in our facility (Modibbo Adama University Teaching Hospital, Yola) was not functional, and the closest location to get one was approximately 4 h away (in Gombe state) or more (in Bauchi if that of Gombe is not in operation). In addition to the risk of plunging the arrowhead deeper due to its snug attachment to the orbital roof, we decided on retrograde extraction of the arrow through a "right superior medial transorbital extraconal subfrontal extradural approach" through a superior eyelid incision that extends inferiorly to involve the entrance wound based only on the findings of the skull X-ray. We planned to (a) dissect around the arrow down to its entry point at the skull base, (b) drill around the entry point of the arrow, (c) extract the arrow under direct vision, (d) evacuate extra-axial and intra-axial hematoma, (e) secure hemostasis and possible cautery of anterior ethmoidal artery if seen to stop persistent meningeal bleed if encountered, (f) watertight closure of the dura because we suspected that the patient might have the arrow pierced through the anterior subfrontal lobe thereby causing dura laceration with attendant intraparenchymal hematoma and possible extra-axial hematoma. We decided on this approach because it is less invasive, affording quick recovery, with the benefits of proximal control of commonly encountered ethmoidal arteries (which we would have ligated if encountered).

Intra-operatively, 20 cm arrow, 1 cm lateral to the right medial canthus in the upper eyelid, parallel to the midline, 80° to the skull base, with its 2.5 cm head and barbs buried in the substance of the muscle in the superomedial aspect of the right orbit and approximately 1 cm of the arrow tip attached to the orbital roof. Through a medial curvilinear superior eyelid incision extending to the entrance of the metallic shaft, the arrowhead was dissected out up to the dehisced orbital roof and was retrogradely extracted, and since there was no evidence of CSF egress on Valsalva maneuver, the wound was copiously irrigated with antibiotic-containing normal saline and closed in layers with the muscles apposed with 3/0 vicryl to reduce dead space and prevent CSF leak, the subcutaneous layer with 3/0 vicryl and the skin with 4/0 prolene (interrupted vertical mattress to allow for egress in the event of infective collection) as seen in Figures 2a-e. The wound was dressed with povidone-iodine, and the patient was placed on initial parenteral and subsequent oral antibiotics for 10 days when sutures were removed [Figure 3]. Postoperative visual acuity was 6/6 bilaterally, and the patient was discharged on the 3rd postoperative day. The patient was seen 8 weeks postoperative with no sequelae.

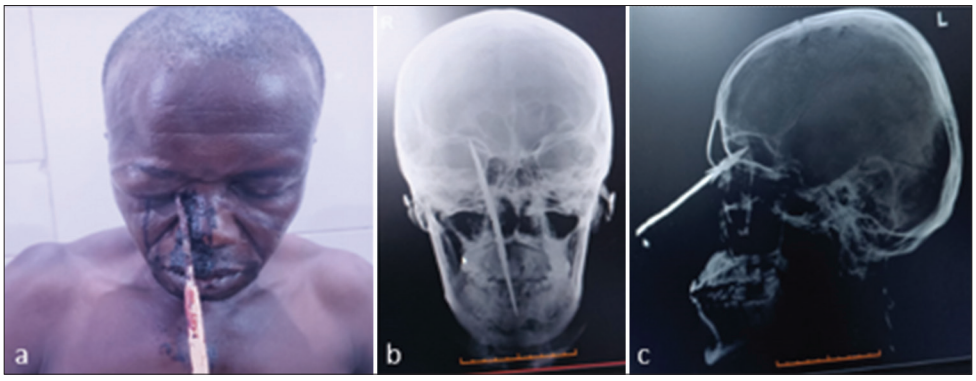

Figure 1: (a)The 50-year-old man with right medial canthus (upper eyelid) transorbital intracranial arrow injury following farmer-herders crisis; skull x-ray (b) Showing transorbital subfrontal arrowhead impalement just lateral to the right frontal sinus, (c) with subfrontal aerocele.

Figure 2: Intra-operative process - (a) Patient draped with an arrow in situ; (b) soft-tissue dissection around the arrow; (c) arrow retrogradely extracted with no cerebrospinal fluid egress following Valsalva maneuver; (d) Wound closed in layers; (e) extracted arrow.

Figure 3: Sutures removed 10th postoperative day.

DISCUSSION

With the increase in high-velocity missiles such as shotguns and rifles due to banditry insurgency in northern Nigeria, the region has witnessed an increase in missile injuries. However, due to the same reasons, the resurgence of low (stab wounds) velocity and intermediate[17] (arrows) velocity missiles have also been witnessed. The muzzle velocity of a shotgun is 250 m/s, while that of a rifle is 750m/s.[17] The average velocity of an arrow from a crossbow is 60–90 m/s, and this is enhanced particularly when an advanced compound bow with a draw strength of 25–80 lb is deployed.[17] Despite this wide difference in velocity, it is the impact velocity that determines the severity of the injury inflicted by the missile; hence, an arrow injury could cause injuries as severe as that of a high-velocity missile if it has a similar impact velocity on the affected tissue. It has been suggested that the impact velocity of 100 m/s on the tissue separates a high from a low-velocity missile injury.[12,17] Below this level of impact, the injuries inflicted are laceration and maceration. Above this impact velocity and, in particular,>320 m/s (as would be expected in a high-velocity missile), shock waves and cavitation are created.[17]

Bill, in his work, noted that arrow wounds are both punctured and incised.[4,20] The entry and exit wounds are slit, and in the event that there was no exit wound, it could be mistaken for a bullet wound. The arrowhead may cause a gush of discharge from the cavity it created and tamponade surrounding structures; hence, the arrow should only be extracted in the operating room under strict aseptic conditions. He also noticed in his review of 154 cases that arrow injury to the upper extremity (29.8%) was the most common, followed by the abdomen (22.07%), chest (18.66%), head and neck (17.33%), lower extremity (12%), and finally heart (1.33%)[4,20] as the aim of the assailant is to kill their victim.

The index patient was a victim of the farmer-herdsmen crisis,

which made up 20% of arrow injuries to the head and neck recorded by Adamu *et al*.,[2] and 17.8% of all arrow injuries by Madziga.[15] in northeast Nigeria. However, other studies reported arrow injuries due to recreational activities such as hunting, archery, initiation rites, armed robbery, being shot by a psychotic relative or inebriated friend ("William Tell" injury), or self-inflicted.[5,13,14,17,18,22]

Due to the sponginess of the facial bones, arrows could lodge at various depths[4,20] (ranging from lodging in the paranasal sinuses, temporal bone, anterior fossa, middle fossa, posterior fossa, and the occipital bone) in the head, causing various degree of injury (ranging from superficial soft tissue injuries, sinus walls fractures, skull base fractures, dura lacerations, cerebral, cerebellar, and brainstem injuries),[13,14,18,19,20,22] and closing off neatly, thereby posing difficulty to the surgeons.[4,20] The roof of the orbit deserves special mention in that it is the weakest (sometimes dehiscent) of the four walls of the orbit,[8] hence an arrow fired from a long distance (>60 m) can easily penetrate and lodge in the orbital roof as seen in the index patient. It is also related to the anterior skull base, slightly away from the paranasal sinus,[8] hence the absence of infection as a complication following the arrow injury in the patient. More so, most of the reported cases of transorbital arrow injuries had injury of the ipsilateral globe with or without intracranial injuries.[2,15,16,17] However, the index patient, just like the one reported by Ibrahim *et al*.,[14], had no global involvement. He only bled from the site of arrow entry, as seen in facial missile wounds, and had no alteration in the level of consciousness or sensorimotor deficit as seen in most cases of arrow injuries when presented alive to health facilities. More so, this patient whose arrow injury is at the anterior skull base through the medial canthus might have his anterior ethmoidal artery injured and tamponade by the arrowhead. Other similar arteries just posterior to the anterior ethmoidal artery are the middle and posterior ethmoidal arteries, all of which are branches of the ophthalmic artery. These vessels should, therefore, be identified preoperatively on bone window CT scan and confirmed intraoperatively for the single purpose of ligate, clipping, or cauterizing early on during a procedure involving them. The inadvertent injury of these vessels before cautery leads to its retraction into the orbit, resulting in orbital hematoma and visual impairment.[11] There are varying locations and distances of the anterior, middle, and posterior ethmoidal arteries bearing in mind the middle being mostly absent, which can affect the anatomical distance of the others from the skull base.[21,24] The middle ethmoidal artery exists in patients in whom the distance of the posterior ethmoidal artery from the skull base is short.[24] According to the CT scan analysis of Yamamoto *et al*., 12% of the patients had their posterior ethmoidal arteries more than 2.0 mm from the skull base, similar to that of anterior ethmoidal arteries. The posterior ethmoidal artery is located nearer to the optic nerve than the anterior ethmoidal artery, making it difficult to either coagulate or clip the posterior ethmoidal artery.[24] Furthermore, Szczepanek *et al*., in their meta-analysis, found that the anterior ethmoidal artery is generally classified as type A (i.e., embedded on the skull), type B (i.e., coursing at the level of the skull base), and type C (floating in the ethmoid sinus), with type A and B relatively more common.[21] Furthermore, with the advancement in endoscopic sinus and endoscopic skull base surgery techniques, strategies to handle obviously enlarged anterior ethmoidal arteries have been documented. These include (a) ligation of the vessels preoperatively, especially in highly vascular olfactory groove meningioma surgery as revealed by Aref *et al*.,[3] (b) endoscopic ligation for refractory epistaxis,[10] and (c) the external approaches which come with the disadvantage of obvious scars involve anterior ethmoidectomy and exposure of the nasofrontal recess, followed by cauterization or placement of a clip on the orbital side of the vessel.[21] The previous practice of embolization of the vessels has been abandoned due to the involvement of the parent artery, invariably resulting in blindness.[23]

Arrow injuries are not commonly associated with mortality since, in most cases, the arrowheads tamponade vital vessels, and so it was admonished by Bill that the arrows may be extracted only in centers with facilities to manage such injuries. The patient arrived at our facility with a 20 cm snugly-fitting arrow (with its 2.5 cm head and barbs) buried in the right medial canthus and crusted blood around the entry point. The patient immediately had plain X-rays, which revealed the position of the arrow tip in the right median anterior skull base with subfrontal aerocele. Bone window with or without angiography (depending on the location of the arrowhead on X-ray) is a vital image modality in the management of cranial arrow injury. However, in the event where a CT scan is not functional,[12] like in ours, and the competence to decide with an X-ray is available, the arrows or missile can be extracted anterogradely or retrogradely, and the tract debrided thoroughly, hematoma evacuated, hemostasis secured, dura closed in a watertight fashion, and the wound closed in layers.[4,12,14,17-20] The choice of extraction will depend on the depth of penetration of the arrow relative to the tissues as well as its relationship to vital structures. If the arrow is superficial, like in our index case, with no risk of damage to adjacent vital structures, it is better removed through the entry point (retrograde approach).[1]

One option of surgery in this patient is a bifrontal craniotomy, breaking the arrow close to the entrance wound, anterograde extraction of the arrowhead, and cranialization and exenteration of the suspected involved frontal sinus. However, the morbidity and mortality involved in this option and considering our findings on plain skull X-ray made us opt for the safest option with the quickest recovery. Hence, we decided to extract the

arrowhead whole retrogradely through the "superior medial transorbital extraconal subfrontal extradural approach." There are many benefits of a transorbital approach, be it endoscopic or microscopic.[6,7,9] Just like endonasal approaches, it can be used to approach the skull base from anterior through middle to posterior skull base. It also has the benefits of a minimum of subtotal tumor excision, vascular ligation and clipping, and retrograde arrowhead extraction (which our patient benefited from). Therefore, this patient had retrograde extraction of the arrowhead because its barbs were wholly in the soft tissue of the orbit, with its tip in the anterior skull base, and since there was no CSF egress on Valsalva maneuver, there was no attempt to suture the dura but the soft tissue was closed watertight to reduce dead space and prevent CSF leak. The patient had no active bleeding and no vessel visualized through the operative field; therefore, there was no need to identify the ethmoidal arteries for cauterization or ligation. The arrow tip did not transverse the paranasal sinus; hence, the patient had a reduced risk for infection. However, the patient was placed on parenteral (initially for 3 days) and then oral (subsequently for 7 days) antibiotics, just like in other studies where antibiotics were also administered for 10 days. In most studies, patients were discharged on the tenth;[14,16,18,22] however, this patient was discharged on the 3rd day and was seen on the 10th day for suture removal.

CONCLUSION

Although CT bone window and angiography are the gold-standard imaging tools in arrow injury to the head, X-ray still has a role sometimes as a standalone imaging tool in low-resource settings. Retrograde extraction of arrowheads can still be done if the arrowhead has not gone deeply intracranial after careful dissection of the surrounding soft tissue from the arrow barbs.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Abdullahi H, Adamu A, Hasheem MG. Penetrating arrow injuries of the head-and-neck region: Case series and review of literature. Niger Med J 2020;61:276-80.
2. Adamu A, Garandawa HI, Nuhu AM, Farate A, Kodiya AM, Abdulrazaq A, *et al*. A review of arrow shot injuries to the head and neck in Northeastern Nigeria. Borno Med J 2021;18:1-7.
3. Aref M, Kunigelis KE, Yang A, Subramanian PS, Ramakrishnan VR, Youssef AS. The effect of preoperative direct ligation of ethmoidal arteries on the perioperative outcomes of large anterior skull base meningiomas surgery: A clinical study. World Neurosurg 2018;120:e776-82.
4. Bill JH. Sabre and Bayonnete wounds, arrow wounds. In: Arshhust J, editor. The International Encyclopedia of Surgery: A systematic treatise on the theory and practice of surgery. Vol. 2. United States: William Wood; 1882. p. 101-7.
5. De Jongh K, Dohmen D, Salgado R, Ozsarlak O, Van Goethem JW, Beaucourt L, *et al*. "William Tell" injury: MDCT of an arrow through the head. AJR Am J Roentgenol 2004;182:1551-3.
6. De Notaris M, Sacco M, Corrivetti F, Grasso M, Corvino S, Piazza A, *et al*. The transorbital approach, a game-changer in neurosurgery: A guide to safe and reliable surgery based on anatomical principles. J Clin Med 2023;12:6484.
7. De Simone M, Zoia C, Choucha A, Kong DS, De Maria L. The transorbital approach: A comprehensive review of targets, surgical techniques, and multiportal variants. J Clin Med 2024;13:2712.
8. Di Ieva A, Lee J, Cusimano M. Handbook of skull base surgery. Uttar Pradesh: Thieme Publishers; 2016. p. 43-6.
9. Feller C, Martinez Del Campo E, Eraky AM, Montoure A, Maloley L, Harrison G, *et al*. Transorbital approach for resection of intracranial skull base lesions: Outcomes and complications. Interdiscip Neurosurg 2023;32:101747.
10. Floreani SR, Nair SB, Switajewski MC, Wormald PJ. Endoscopic anterior ethmoidal artery ligation: A cadaver study. Laryngoscope 2006;116:1263-7.
11. Gifford TO, Orlandi RR. Epistaxis. Otolaryngol Clin North Am 2008;41:525-36, viii.
12. Hammon WM. Analysis of 2187 consecutive penetrating wounds of the brain from Vietnam. J Neurosurg 1971;34:127-31.
13. Harsh V, Alda H, Singh S, Kumar J, Sahay CB, Kumar A. Arrowhead injury of central nervous system: Three rare cases from rural India. Indian J Neurotrauma 2021;18:138-41.
14. Ibrahim AI, Murhega RB, Samuila S. A hunting arrow traumatism to the head: A case report from Niger. Clin Case Rep 2023;11:e7750.
15. Madziga AG. Arrow injuries in North East Nigeria. West Afr J Med 2003;22:106-9.

16. Mono J, Hollenberg RD, Harvey JT. Occult transorbital intracranial penetrating injuries. Ann Emerg Med 1986;15:589-91.
17. O'Neill OR, Gilliland G, Delashaw JB, Purtzer TJ. Transorbital penetrating head injury with a hunting arrow: Case report. Surg Neurol 1994;42:494-7.
18. Ogunleye AO, Adeleye AO, Ayodele KJ, Usman MO, Shokunbi MT. Arrow injury to the skull base. West Afr J Med 2004;23:94-6.
19. Paramhans D, Shukla S, Batra A, Mathur RK. Successful removal of an impacted metallic arrowhead penetrating up to the brainstem. J Emerg Trauma Shock 2010;3:303.
20. Shereen R, Oskouian RJ, Loukas M, Tubbs RS. Treatment of arrow wounds: A review. Cureus 2018;10:e2473.
21. Szczepanek E, Toppich J, Ostrowski P, Bonczar M, Nasser A, Dziedzic M, *et al*. The complete anatomy of the anterior ethmoidal artery: A Meta-analysis with implications for sinus and skull base surgery. J Clin Med 2024;13:1695.
22. Usman B, Mohammed B, Shuwa FA, Garandawa HI. Penetrating intracranial arrow extraction: Our experience. Borno Med J 2020;17:1-7.
23. White DV, Sincoff EH, Abdulrauf SI. Anterior ethmoidal artery: Microsurgical anatomy and technical considerations. Neurosurgery 2005;56:406-10; discussion 406-10.
24. Yamamoto H, Nomura K, Hidaka H, Katori Y, Yoshida N. Anatomy of the posterior and middle ethmoidal arteries via computed tomography. SAGE Open Med 2018;6:2050312118772473.

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