

## Penetrating Intracranial Arrow Extraction: our Experience

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### ABSTRACT

**Background:** Arrow injury is one of the causes of non-missile penetrating head injury. Penetration may be through natural openings like the eye, nose, or a thin bone. At presentations, most patients are clinically stable. However, some may present with catastrophic vascular injury. Non-contrast Computed Tomography (CT scan) with or without angiography, when indicated, is essential for surgical planning. When impacted to a bone, craniectomy is an option, but when not impacted the best option is a craniotomy with antegrade extraction under vision especially when the arrow is barbed. Often surgery may involve multiple specialists. Broad-spectrum antibiotic prophylaxis is advised likewise tetanus and seizure prevention. Postoperatively patients are followed up and complications are treated.

**Keywords:** Arrow, Head injury, Craniotomy, Antegrade, Extraction.

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### Introduction

Based on the mechanism, head injuries are classified into non-penetrating or penetrating type.<sup>1</sup> The latter may be caused by a missile or non-missile cause. A penetrating head injury (PHI) refers to a situation where a projectile has breached the cranium but does not exit it<sup>1</sup>. PHI constitutes about 0.4% of all head injuries, where the foreign body produces

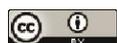
injury to the brain in about 10% of cases.<sup>2</sup> Non-missile causes (Knife and arrow) PHI are characterized by a low-velocity impact of < 100 m/s and cause damage by laceration and maceration, unlike missile injury that damages by kinetic and thermal energy.<sup>3</sup> Studies revealed that arrow-injury has killed more individuals than any other weapon in history.<sup>4</sup> Despite this, many physicians and surgeons today regard this weapon as an uncommon cause of traumatic injuries.<sup>4</sup> Madziga found arrow injuries to account for 0.1% of all emergency admissions in a Nigerian tertiary health institution.<sup>5</sup> This is significant when one considers the fact that arrow injuries are virtually extinct in most developed countries. The incidence in our setting is common among Hausa - Fulani ethnic groups of Nigeria who use arrows and spears for hunting and self-defence.<sup>6, 7,8</sup> Penetration may result in damage to brain tissue with possible vascular laceration or occlusion, without the surrounding blast effect seen with high-velocity injuries.<sup>9</sup> The distance of the assailant from the target, the fork, and the trajectory of the arrow, as well as the physical characteristics of the arrow,

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determine the severity of the injury.<sup>10</sup> Arrows consist of a metallic 'arrowhead' and a wooden/stick 'shaft'. According to Bill, an arrowhead is made of metal while the shaft is made from the dogwood branch.<sup>11</sup> The arrowhead is attached to the prepared dogwood shaft using tendons and sinews. Papuan traditional hunters use a variety of arrowheads for warfare, which may be serrated, barbed, jagged, lined with porcupine quills so that they do gruesome damage when they're removed.<sup>12</sup> Also, the laced orchid fiber bits tend to stay inside the wound leading to infection<sup>12</sup>.

Following penetrating head injuries, likely complications include possible meningitis, abscess, seizures, pneumocephalus, vascular laceration or occlusion with hematoma, aneurysm, pseudoaneurysm, and carotid-cavernous fistula.<sup>9</sup>

Computed Tomography (CT) scanning of the head is the imaging of choice for evaluating any penetrating cerebral trauma.<sup>13</sup> It helps in localization of the projectile, any fragments, bony destruction, in-driven debris, and identification of any hematoma, contusion, mass effect, intraventricular haemorrhage (IVH), or subarachnoid haemorrhage (SAH) which also provides prognostic information. Magnetic resonance imaging (MRI) is contraindicated in patients with penetrating cerebral trauma involving metal fragments because of the additional injury caused by migration of the fragment in response to the magnetic field.<sup>13</sup> Cerebral angiography should be performed in cases of suspected vascular injury in areas with haematoma and SAH.<sup>13</sup>

Treatment of most arrow injuries require a multidisciplinary team consisting of Ophthalmologist, Otorhinolaryngologist (ENT), Maxillofacial, and Neurosurgeons.<sup>14</sup>

We report a case of antegrade intracranial arrow extraction via a temporal craniotomy.

### Case Summary

An 18-year-old Fulani man was referred from a secondary health institution to our facility with a 4-day history of mid-face arrow injury. He was shot on at a close range (< 50 m) following a conflict with some friends. There was some blood loss from the entry point but no Cerebrospinal Fluid (CSF) leakage and no bleeding from craniofacial orifices. He had not lost consciousness, seizure, or developed a neurological deficit, or features suggesting raised intracranial pressure. He was rushed to the referring hospital where he was resuscitated; he had skull X-ray and head Computed Tomography (CT scan) before referral to our facility for expert management. At presentation, he was found to have stable vital signs, conscious and oriented in person, place, and time. Not pale, afebrile, and not in any obvious distress.

Has an arrow in - situ with the wooden/stick part cut close to the metallic head at the referring hospital for ease of doing CT scan and transport. With its Wooden part resting on the nose surrounded by crusty discharge. The entry point was to the right side of the nasal bridge, pointing towards the medial angle of the left eye, oriented about 40° lateral to the midline and about 35° below the skull base as shown in Figure 1a. His vision was normal and no neurological deficit and other systems were normal. Antibiotic prophylaxis covering gram-positive, gram-negative, and anaerobic bacteria was commenced. He was given tetanus protection and anticonvulsants commenced. Because of the trajectory of the arrow, he was reviewed by an otorhinolaryngologist and ophthalmologist for possible multidisciplinary care.



His packed Cell Volume (PCV) was 34%, his Electrolytes, Urea, and Creatinine were within the normal range, likewise his Random Blood glucose. Blood was grouped and cross-matched. His skull X-ray (Figures 1b and 1c) showed a barbed arrow traversing the left nasal cavity, passing through the medial wall of the orbit, then the orbital apex. The Head CT Scan as shown in Figure 2a-c revealed the following: Arrow passing through the left nasal cavity, medial wall of the orbit pushing the globe laterally, entered the cranial cavity beside the orbital apex (optic canal) with its intracranial tip reaching the left temporal region, within 1.5 cm of temporal squama with surrounding brain contusion.

He underwent left temporal craniotomy and antegrade extraction of the arrow. Surgery was done under general anaesthesia with a cuffed endotracheal tube in-situ. The patient was in the supine position, head end of the table elevated to 25° to minimize blood loss, head rested on a head ring, and rotated to the right. The left side of the head shaved, the operative site and the exposed part of the arrow cleaned and draped exposing the operative site and the arrow. The wooden/stick component nibbled off exposing a short metallic component (about 5 cm long) that was cleaned with

Chlorhexidine gluconate, methylated spirit, and covered with povidone-iodine-soaked gauze. Left temporal craniotomy was done, dura opened, followed by corticectomy. Under direct vision, the arrow was held (as in figure 3a) firmly and via a gentle, progressive ante grade pull, with minimal rotatory movements, it was successfully extracted out at the temporal end as shown in figure 3b. No significant bleeding, craniotomy closed in layers, and surgical wound cleaned and dressed. The Arrow tract was irrigated with dilute Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>) from the facial wound. The nasal wound was explored, debrided, and closed by the otorhinolaryngologist while the ophthalmologist re-assessed the eye on the table. Postoperatively, antibiotics (intravenous ceftriaxone and metronidazole then oral amoxicillin/clavulanic acid and metronidazole) were continued for 14 days, had prophylactic anticonvulsant (parenteral phenobarbitone then carbamazepine) for 7 days. No post-operative seizure, neurological deficit, visual disturbance, epistaxis, or CSF leakage. Wound stitches were removed on day 10 (figure 3c), and he was discharged home. He was followed up thrice over a 6 uneventful month period.



**1a** **1b** **1c**  
Figure 1: Picture showing arrow insitu (1a), Skull X-ray lateral view (1b), and AP view (1c) showing arrow passing through the nasal cavity and left orbit into the cranial cavity.

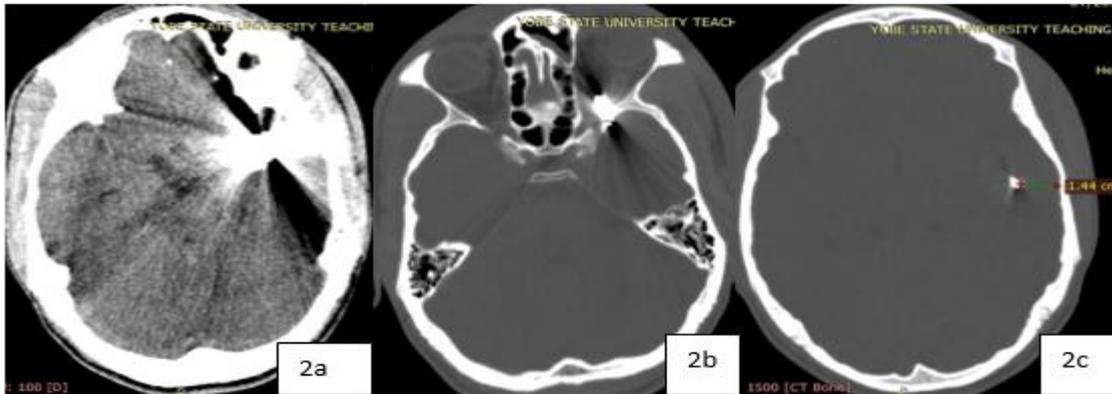


Figure 2: Computed Tomography scans (CT scans) showing a left-sided intracranial arrow appearing as a metallic artefact('scatter') in brain window(2a), a Bone window of 2a showing the intraorbital arrow passing close to the optic canal (2b), and a Bone window showing an arrow tip within 1.5 cm of left temporal squama (2c).



Figure 3: intraoperative picture showing an arrow tip lying on brain spatula held by a needle holder (3a), picture of the extracted, barbed arrow (3b), and a picture showing healed left side craniotomy scar (3c).

## Discussion

Our patient is a young man whose age and period of delay in presentation falls within the median ranges of 18-65 years and 3h-10days respectively as reported by Brijesh in western India.<sup>15</sup>

In Papua New Guinea, it was reported that the main reason for arrow shot injuries is sociocultural factors like adultery, theft, or death of a pig or young male.<sup>16</sup> This is not far from the reason why our patient was attacked, Likely woman/sexuality related to the conflict. This is further supported by the observation of Monsieur Paul Riesman, following his interaction with the Fulani ethnic group.<sup>8</sup> A reported by Amole et al found that most arrows shot patients were nomadic farmers of Fulani descent, typically from the Northeastern part of Nigeria

(58.3%)<sup>7</sup>. At presentation, our patient was haemodynamically stable with stable vital signs as in the report by Gerald V<sup>16</sup>.

Initial Skull X-ray gave us an idea about the extent of penetration of the arrow. It has been reported that a plain radiograph of the skull helps in revealing an unsuspecting skull fracture and delineating the depth and direction of penetration.<sup>17</sup> further imaging is by CT scan which gives detailed information about the characteristics of the arrow and above all aids in planning the direction of extraction.

Therefore, CT scan is important for planning surgical strategy.<sup>18</sup> despite its importance; the interpretation of CT scans in the presence of metallic artefacts (arrow) is difficult.

The effect of the metallic artefact is referred to as 'scatter'. To minimize the scatter, a detailed review of a non-contrast CT scan with bone window is recommended.<sup>18</sup>

The arrow was left intact except for a minor reduction in length of the shaft to allow for easy positioning of the patient during imaging. The fixating tendon was unwound and removed before the extraction. A pioneer worker (Bill J H) on the management of arrow injuries had laid down rules that are still relevant for the safe removal of it.<sup>19</sup> He noted that an intact shaft provides a guide to the arrowhead and indicated the involvement of bone when twirled gently. He also noted that if the arrowhead is disengaged from the shaft during an extraction effort, the fixating tendon may be left behind and may subsequently cause infection and abscess. For these reasons, Bill recommended leaving the arrow undisturbed until the victim could receive medical treatment; thus, one of the basic rules taught to recruits was 'never apply traction to the shaft.'<sup>19</sup>

The patient had Craniotomy and the arrow was cautiously extracted in an antegrade direction. Craniotomy allows the removal of intracranial foreign bodies with direct visualization especially after preparations for vascular control have been made.<sup>13</sup> However, removing an impacted arrow may require craniectomy.<sup>20</sup>

Neil et al suggested that arrows with barbs should be removed in an antegrade direction along the line of its trajectory to avoid snagging blood vessels and other structures.<sup>21</sup> likewise, Amole et al advocated antegrade extraction of the arrow because they felt that Retrograde removal of arrowheads in the presence of structures of vascular importance and deterrents such as barbs may facilitate the arrow "hitting all it had missed on its way in" with catastrophic consequences.<sup>7</sup>

The need to commence pre and postoperative prophylactic broad-spectrum antibiotics cannot be overemphasised, with the known fact that there is a very high likelihood of infection as reported by Bayston, Guthkelch, Neal, Long, and Mutlukan.<sup>22-26</sup> Patients should be protected from tetanus.

The use of prophylactic anticonvulsant for 7 days is supported by level I evidence as suggested by Temkin.<sup>27</sup>

His postoperative period was not eventful. It is recommended that postoperatively, patients are monitored for any evidence of neurological deterioration especially from tissue damage, infections, and vascular complications.<sup>9</sup>

### **Conclusion**

The purpose of surgery in penetrating head injuries is the removal of the foreign body and the debridement of the affected tissues following the emergent stabilization of the patient. Penetrating head trauma from arrow shots may lead to potentially life-threatening injuries.

Preoperative planning based on CT scan with 3D reconstruction, Prophylactic antibiotics, and anticonvulsant medications, cleaning of the objects with antiseptic solutions, antegrade extraction after adequate craniotomy around the extracting point results in good clinical outcome.

A craniotomy and an antegrade method of extracting an arrow are preferred over a blind (closed) removal or retrograde extraction, especially in barbed arrows.

This technique ensures minimal chances of neurological and vascular complications. Postoperatively patients are closely monitored and followed up to identify complications like sepsis, post-traumatic



meningitis, CSF leak, and pseudoaneurysm should be anticipated.

Considering the great variability of trauma mechanisms and possible associated neurological deficits, each patient should be treated individually.

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