ELSEVIER

TRAUMA

# Transorbital Penetrating Head Injury with a Hunting Arrow: Case Report

Oisin R. O'Neill, M.D., F.R.C.S.I., Grant Gilliland, M.D., Johnny B. Delashaw, M.D., and Thomas J. Purtzer, M.D.

Divisions of Neurosurgery and Ophthalmology, Oregon Health Sciences University, Portland, Oregon; and Rogue Valley Neurosurgical, Medford, Oregon

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.

**The development of more complex and diverse hunting weapons may result in an increase of uncommon forms of penetrating injury to the brain. We present a case of nonfatal transorbital arrow injury to the brain. High velocity projectile injuries merit certain management adaptations from gunshot or low velocity stab wounds. This case highlights the necessity for anterograde removal of the arrow in the direction of its line of trajectory. Early assessment of the patient with cerebral angiography to identify surgically correctable vascular injury is recommended.**

KEY WORDS: Angiography; Arrow; Orbital injury; Penetrating head injury

Missile injuries to the head account for the majority of penetrating wounds of the brain and are responsible for a significant number of deaths in the civilian population. The majority of these injuries are related to gunshot wounds. Technological advances in weaponry may be associated with a complex and potentially devastating variant of penetrating head injury from arrows. The fundamental principles of surgical management include the prevention of early or late infection, control of intracranial pressure, and prevention of secondary injury to the damaged tissue. Penetrating injuries to the orbit, brain, or both by high velocity arrows may require some management strategies that differ from those due to injuries caused by gunshot wounds. We report a unique case of transorbital brain injury by a broadhead arrow. Review of the literature reveals no previous reports of this type of injury. We also discuss the neurosurgical and ophthalmologic management strategies.

*Address reprint requests to:* Oisin R. O'Neill, M.D., F.R.C.S.I., Division of Neurosurgery, L-472, Oregon Health Sciences University, 3181 SW Sam Jackson Park Road, Portland, OR 97201.

Received March 18, 1994; accepted June 1, 1994.

## Case Report

A 25-year-old man was admitted to a regional trauma center after an arrow penetration of the right eye. The injury reportedly occurred during an initiation rite to an outdoors club in which the patient, in an inebriated state, attempted to prove his bravery by placing a fuel cannister atop his head and allowing his equally inebriated friend to shoot it off in a classic "William Tell" maneuver. The can was missed and the arrow penetrated the right eye. There was no reported loss of consciousness and the patient was transferred to a regional hospital and subsequently by helicopter to our institution. He had been prevented by attendant medical staff from attempting to remove this arrow on numerous occasions during transport.

On admission the patient was alert and oriented and asked to have the arrow removed. General examination revealed the right orbit to be penetrated by an aluminum shaft arrow, the point of which was palpable beneath the scalp in the posterior occipital region approximately 2 cm above the transverse sinus and 4 cms lateral to midline. There was no bruit or pulsatile proptosis. Ocular examination revealed a disorganized right eye with no light perception. Detailed neurologic examination revealed a normal mental status. There was a pronator drift and diminished fine motor control of the left hand. Cranial nerve examination demonstrated a 20/80 visual acuity and a temporal hemianopsia in the left eye (amblyopic by history). There were no other deficits. The patient had no other sensorimotor deficits and plantar responses were flexor bilaterally.

A computed tomography (CT) scan demonstrated the transorbital transcranial trajectory of the arrow and fragments consistent with blades along that trajectory. There was an associated hematoma along the tract and a thin subdural hematoma over the temporoparietal region with mild mass effect causing effacement of the ipsilateral lateral ventricle. Bone windows demonstrated the arrow to have passed through the posterior aspect of the lateral orbital wall, the anterior temporal wall, and partially



0090-3019/94/$7.00

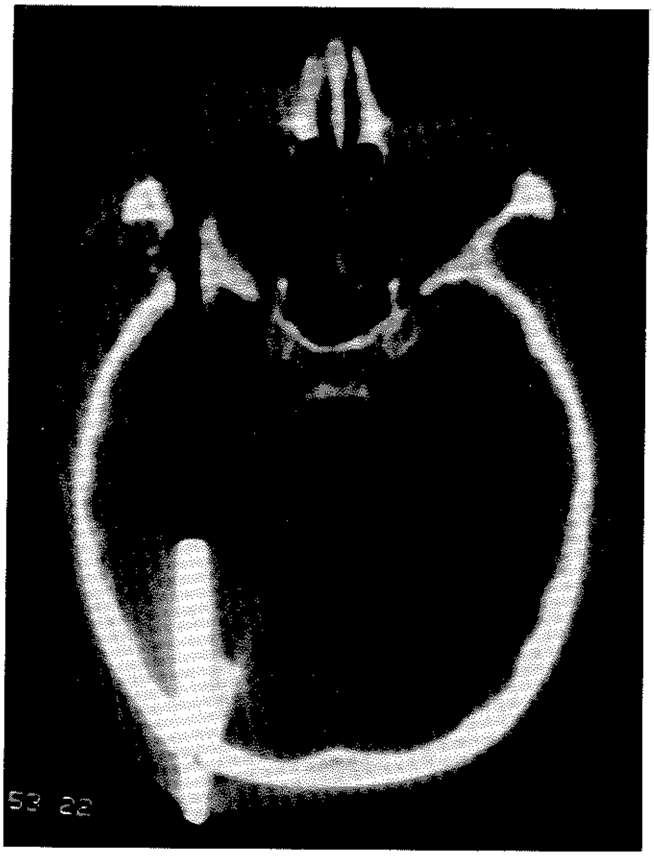


**Figure 1.** *Transaxial CT scan demonstrating arrow trajectory, incomplete penetration of occipital bone, and intracranial arrowhead blades.*

through the occipital bone (Figure 1). Only the point of the arrow traversed the occipital bone with the blades remaining predominantly intracranial. Urgent cerebral angiography was performed in order to identify vascular pathology (Figure 2). No abnormality was evident other than mild vessel displacement from a temporal mass.

In the operating room, general endotracheal anesthesia was induced, and the patient was positioned supine with a right shoulder roll. The head was placed in three-point fixation and turned 70° to the left. The arrow was noted to be rigidly fixed in the skull. It was cut off at 12 cm from its entry point with a high-speed drill and the edges were filed smooth. Prophylactic antibiotic therapy was used. As the barbs of the arrow were intracranial, we felt that the arrow needed to be pulled through the brain along its original trajectory in order to minimize damage from these razor sharp blades. An identical arrow had been obtained and this proved valuable in defining operative strategy. It enabled accurate determination of the position of the blades relative to the arrow tip that highlighted the danger of attempting any other path of removal.

A pterional flap was performed anteriorly. A sheared blade of the arrow tip was encountered in the temporalis muscle at the anterior temporal entrance site. Utilizing a high-speed drill, the arrow shaft was freed from the temporal bone and a formal pterional craniotomy was performed. After this, a small horshoe flap was performed posteriorly over the palpable subcutaneous arrow tip. The tip, completely unaltered by its passage through two skull plates, was visible extrancranially. Again, the high speed drill was used to perform an occipital craniectomy around the arrowhead at the exit site. Dural lacerations at both sites were extended surgically, and necrotic brain and hematoma were debrided. After complete disengagement of the arrow from the skull, it was advanced through the brain along its path of trajectory approximately 1 cm to allow retrieval of the arrowhead barbs that were embedded in the occipital lobe. These blades were identified, disengaged from the shaft, and removed from the brain. A silastic ventriculostomy catheter had been placed in the hollow shaft anteriorly, and the arrow was then pulled completely out through the wound through the occipital craniectomy. Again, debridement of superficial necrotic brain was performed. The ventriculostomy tube, which had been pulled through the wound inside of the arrow shaft, was then withdrawn anteriorly with copious irrigation of the parenchymal tract. Dural patch grafts were placed and primary closure was performed at both sites. An intraparenchymal fibreoptic intracranial pressure monitor was placed.

Examination of the eye revealed a stellate laceration of the lids and a disorganized severely lacerated globe. Enucleation of the eye was performed and inspection of the orbit revealed the hole in the posterolateral orbital wall. A

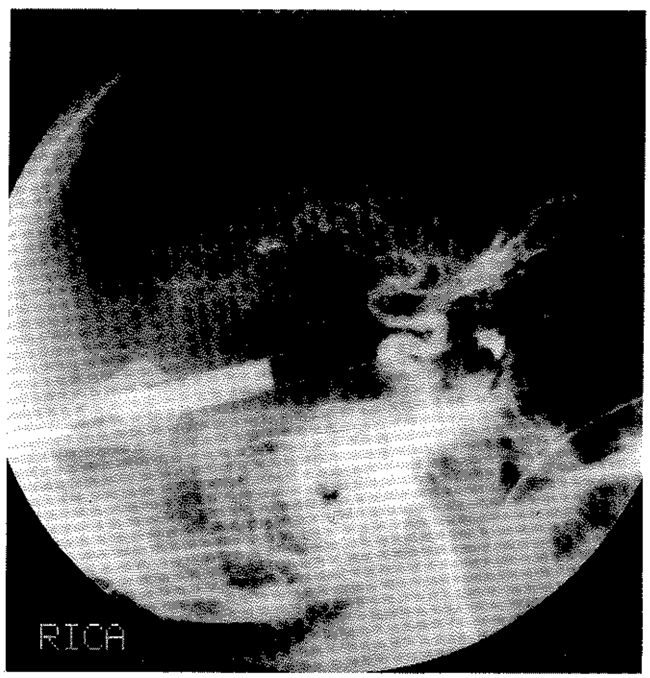


**Figure 2.** *Lateral scout film of internal carotid artery angiogram demonstrating intracranial arrow.*

universal implant was placed in the muscle cone of the orbit with subsequent water tight closure of Tenon's fascia. The lids were also closed in a watertight fashion to prevent development of a cerebrospinal fluid (CSF) fistula.

The postoperative course was uncomplicated with no change in neurologic status and no elevation of intracranial pressure greater than 20 torr. He was discharged from the hospital on postoperative day 8 with well-healed wounds and no evidence of CSF fistula.

## Discussion

The annual incidence of gunshot wounds to the head is 8.2 per 100,000 and these are a major health care problem [6]. Stab wounds to the skull and brain are relatively uncommon, generally the result of knife injury, and are associated with different mechanisms of neuronal and vascular damage because of the low velocity kinetics of the injury [7]. Intracranial pathology associated with perorbital stab wounds has been described [2,7,8]. The craniocerebral trauma inflicted by penetrating missiles will depend on the impact force, missile velocity, and mass. There is little data on the incidence of projectile, nongunshot, penetrating head trauma although injuries with nail guns, rocks, and high-speed impailment have been described [2,6]. Arrow injuries to the brain, other than in tribal conflicts in which the orbit is a prime target, are exceedingly rare [10]. The basic principles of surgical management, however, are unaltered. Thorough debridement with removal of all accessible bone and foreign body material, hematoma evacuation followed by hemostasis, and meticulous closure to diminish the possibility of cerebrospinal fluid fistula is mandatory. Subsequent reduction of secondary cerebral insults and control of intracranial pressure are critical in the management of these patients. A deep-seated bullet need not necessarily be removed because of the potential for further injury and because of the low incidence of postoperative infection with bullet injuries to the brain [6]. However, arrows or other missiles that have an extracranial component must be removed. The most appropriate management in the field is to leave the instrument in situ and carefully transport the patient to a trauma center. Once in a controlled hospital environment, the patient should be assessed completely including angiographic study prior to surgical removal of the foreign body.

Angiography is essential in patients admitted with a weapon embedded in the brain as up to one-third of patients will have potentially treatable vascular complications [2,8]. Traumatic intracranial aneurysms, generally considered to occur after blunt head injury, are being reported more frequently with penetrating head injury [3]. Transcranial stab wounds have been associated with posttraumatic aneurysms in up to 12% of cases and vasospasm in 10% [2,8]. Less frequently, one may encounter arteriovenous fistulae, major vessel occlusion, and venous thrombosis [2,8]. Although controversy exists with regard to timing of angiography, the literature suggests that aneurysms may be identified within hours of trauma and that delay in therapy is associated with possible increased risk of rupture [2,3]. Others suggest a potential for delayed vascular pathology and hemorrhage and, hence, delayed angiography [8]. In a review of 250 patients with cranial stab wounds from whom the stabbing instrument had already been removed, 20% of these being transorbital, 69 patients required craniotomy for evacuation of intracerebral hematoma. Ten percent of the patients with intracerebral hematoma had associated traumatic aneurysms identified that were dealt with simultaneously [2]. The advantages of facilitated surgical planning and the diminished risk of early hemorrhage from traumatic arterial pathology would suggest that early angiography is indicated.

The kinetic energy imparted by a missile is a direct result of its mass and velocity, the latter of which is the most important variable. Missiles damage tissue by transmitting energy beyond that which the tissue can absorb. The advent of more powerful archery equipment has been associated with a dramatic increase in arrow projectile velocity. As with bullet injuries, arrow injuries may be dependent upon the type of bow and arrow used. Arrow shafts are constructed from a variety of materials and are generally equipped with either a field tip or a broadhead tip. The field tip, commonly used in target practice, possesses a tip diameter equal to that of the shaft and entrance wounds closely simulate gunshot wounds [4]. The broadhead, used predominantly for hunting, is generally constructed of aluminum alloy, high-carbon steel, or titanium-nitride of Teflon-coated tips and may be fitted with three to five razor-sharp blades. These may be fixed and, in some cases, made to expand on contact for maximum destruction. The broadhead arrow is associated with a stellate entrance wound and increased tissue destruction [4]. The use of highly advanced compound bows, with average draw strengths from 25 to 80 lbs., has greatly increased the arrow velocity. The average velocity of a broadhead arrow fired from a compound bow is 60 to 90 m/s. In comparison, the muzzle velocity of most handguns is less than 250 m/s and most modern rifles is greater than 750 m/s. However, the velocity corresponding to the degree of tissue destruction is the impact velocity and not the muzzle velocity. It is suggested that an impact velocity of at least 100 m/s is required to effect the explosive type of intracranial damage that often separates high from low fatality head injuries [5]. Below this impact velocity, tissue laceration and maceration are the primary pathologic events. Above this velocity, and in particular at greater than 320 m/s, two other "explosive" pathologic processes, shock waves and cavitation, contribute to tissue damage. It might be extrapolated from these data on gunshot injuries that arrow injuries to the brain may cause significant destruction with kinetic injuries equivalent to low velocity hand guns.

We suggest that high velocity arrow or projectile injuries to the brain should be considered intermediate between bullet and stab wounds. One must stress the importance of safe transport and, in particular, the prevention of removal of the foreign body in the field. We also stress the importance of early angiographic analysis of the patient, preferably before removal of the projectile, in order to identify potential vascular injury or proximity of vascular anatomy to sharp edges.

## References


1. Dannenberg AL, Parver LM, Fowler CJ. Penetrating eye injuries related to assault—The national eye trauma system registry. Arch Ophthalmol 1992;110:849–52.
2. du Trevou MD, van Dellen JR. Penetrating stab wounds to the brain: the timing of angiography in patients presenting with the weapon already removed. Neurosurg 1992;31:905–12.
3. Haddad FS, Haddad GF, Taha J. Traumatic intracranial aneurysms caused by missiles: their presentation and management. Neurosurg 1991;28:1–7.
4. Hain JR. Fatal arrow wounds. J Forensic Sci 1989;34:691–3.
5. Hammon WM. Analysis of 2187 consecutive penetrating wounds to the brain from Vietnam. J Neurosurg 1971;34:127–31.
6. Harsh GR, Harsh GR. Penetrating wounds of the head. In: Wilkins RH, Rengachary SS, eds. Neurosurgery. New York: McGraw-Hill, 1985: 1670–8.
7. Khalil N, Elwany MN, Miller JD. Transcranial stab wounds: morbidity and medicolegal awareness. Surg Neurol 1991;35:294–9.
8. Kieck CF, de Villiers JC. Vascular lesions due to transcranial stab wounds. J Neurosurg 1984;60:42–6.
9. Salvino CK, Origitano TC, Dries DJ, Shea JF, Springhorn M, Miller CJ. Transoral crossbow injury to the cervical spine: an unusual case of penetrating cervical spine injury. Neurosurgery 1991;28:904–7.
10. VanGurp G, Hutchinson TJ, Alto WA. Arrow wound management in Papua New Guinea. J Trauma 1990;30:183–8.