CASE REPORT

Penetrating Injury to the Head: Case Reviews

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SUMMARY

Penetrating injury to the head is considered a form of severe traumatic brain injury. Although uncommon, most neurosurgical centres would have experienced treating patients with such an injury. Despite the presence of well written guidelines for managing these cases, surgical treatment requires an individualized approach tailored to the situation at hand. We describe a collection of three cases of non-missile penetrating head injury which were managed in two main Neurosurgical centres within Malaysia and the unique management approaches for each of these cases.

KEY WORDS:
Penetrating head injury, nail related injury, atypical penetrating head injury

INTRODUCTION

Penetrating head Injury occurs when a projectile breaches the cranium and its contents. The circumstances leading to such an injury are varied and may result from missile wounds, stab wounds, motor vehicle accidents or occupational accidents [1,2]. In this report we highlight three cases of penetrating head injury caused by a nail, a motorcycle kick starter and a metal rod. Each patient was managed with slightly differing strategies to minimize further injury occurring during removal of the projectile while keeping to the standard principles of good debridement and standard parenteral antibiotics.

CASE 1

A 3 year old child was referred from a peripheral hospital after an alleged fall. She had landed on a piece of wood with a nail protruding from its surface. The nail penetrated the skull through the frontal region over the midline about 1cm behind the hair line. There was no history of loss of consciousness following the injury and the child was admitted to the emergency department with a Glasgow Coma Scale Score of 15/15. She was haemodynamically stable did not exhibit any features of raised intracranial pressure or focal neurological deficits. The exact penetration site was obstructed from view due to the presence of the piece of wood to which the nail was attached overlying the site of injury. The nail with its attached wood piece was found to be very mobile and was secured in place with a crepe bandage to the childs head pending transport and investigation.

Plain skull radiographs in the Antero Posterior and Lateral planes revealed a single 6cm long radioopaque nail penetrating the childs skull. A computed tomographic scan was subsequently done and revealed the nail to be lodged in the right frontal lobe to a depth of approximately 2.5cm. (Figure 1: A & B) There was no obvious intracranial haemorrhage along the track of injury. The patient was taken to the operating theatre and was put under general anaesthesia. The nail was cut proximal to the entry wound and the piece of wood removed. The entry wound was found to be contaminated with hair and debris. The nail was also rusty. A bicoronal skin incision was fashioned centred on the entry wound. A bifrontal craniotomy was fashioned and the bone flap removed sparing a small island of bone around the nail (Figure 1: C&D). Bilateral "U" shaped dural incisions were made with the base to the midline. The nail was found to have penetrated with dura about 0.5cm from the edge of the sagittal sinus. The nail was removed with gentle traction and did not result in any overt haemorrhage. The tract was irrigated copiously with saline. The dura was subsequently closed in a water tight manner and the bone flap replaced.

The patient was well post operatively without any neurological deficit. A repeated CT scan done on the 1st Post–operative day revealed no intracranial bleeding. A course of parenteral antibiotics was continued for a one week period and subsequently converted to oral antibiotics for a further two weeks. The patient remained well and did not reveal any evidence of infection. Her operative wounds healed well. A contrast enhancing CT scan of her brain was repeated and revealed no evidence of infection over the injury site. She was discharged well after completing antibiotics and was reviewed in the outpatient clinic 6 weeks after the injury. She was found to have made a good recovery with no evidence of complications.

CASE 2

A 21 year old male presented after an alleged motor-vehicle accident. The patient was a motorcyclist who collided head–on with another motorcycle. He was not wearing a safety helmet at the time. He was admitted with a Glasgow coma Scale Score of 8/15 (E1 V2 M5) but was otherwise heamodynamically stable with no other major organ system injury. An obvious metal projectile was seen protruding out from a penetrating injury in the right frontal region just above the supraorbital ridge.

He underwent CT scan of the brain which revealed a metal object penetrating the right frontal bone and anterior skull base to a depth of 5.75cm (Figure 2:A). A small contusion was seen along the injury tract which transgressed the inferior frontal lobe on the right. The patient was intubated and underwent urgent debridement and surgical removal of the metal object. During transfer, care was taken to ensure that the protruding portion of the metal object was not displaced.

This article was accepted: 8 March 2012
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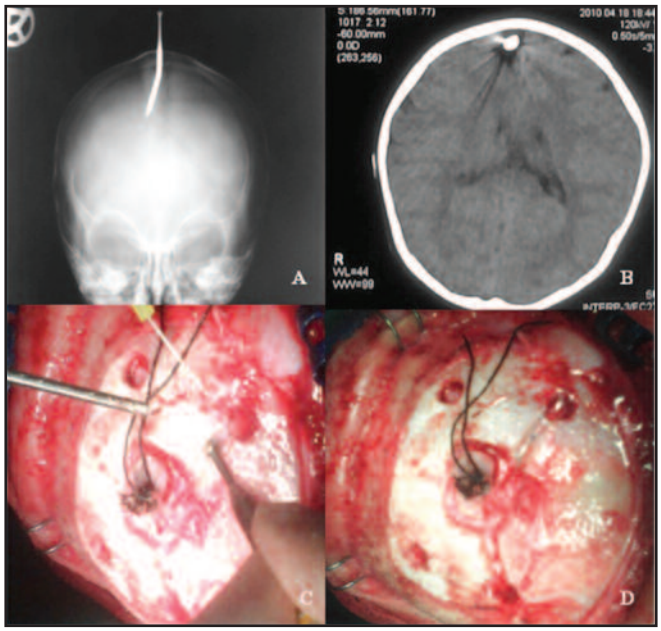

Fig. 1: A: Anterior Posterior (AP) Skull X-rays projections shows the nail penetrating the child's skull in the right frontal region just adjacent to the midline. The nail was noted to be bent and penetrated the underlying brain at an angle. B: Non contrasted Axial Computed Tomographic images shows the nail penetrating the frontal lobe of the brain on the right side approximately 1.5cm deep. C&D: The Bifrontal Craniotomy that was fashioned sparing an island of bone around the nail entry site.

A frontal craniotomy was fashioned on the right side. The fractured fragments were removed and contusion and clot surrounding the metal object was evacuated while meticulously dissecting the metal object free from the surrounding brain tissue (Figure 2:B).The metal object was then slowly pulled out from below without any oscillating movements to prevent any further injury. The object was noted to be a motorcycle kick starter that had broken off. Associated clots were evacuated and the area was then washed with copious amounts of saline. Dura was severely torn with significant loss predominantly in the frontobasal region. Due to difficulties with primary closure in this location a harvested fascia flap was used for Duraplasty. The bone flap was then replaced.

The patient was weaned off ventilation post operatively. A post-operative CT scan showed complete removal of the projectile and associated contusions. The patient was extubated well on the second post-operative day and made a good recovery with no complications excepting anosmia on the (R) side.

CASE 3

A 4 year old child was admitted after having a fall in a shopping complex. He was running and slipped then fell on an exhibition rack. A metal rod from the rack penetrated his cheek and was found on admission protruding out through a tear in his right cheek. The child very much like the first case was well and did not show any neurological symptoms or signs.

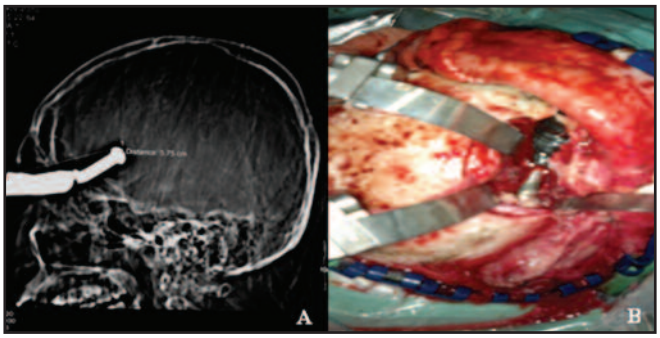

Fig. 2: A: A Lateral CT Scanogram projection depicting the projectile penetrating the anterior cranial fossa.
B: Intraoperative image depicting the projectile within the frontal lobe and surrounding contusions.

Skull radiographs showed a metal rod penetrating the anterior cranial fossa in the region of the midline. CT scan revealed the tip of the rod to be lying ventro-superiorly to the tuberculum sellae.

The patient underwent a right pterional craniotomy. The frontal and temporal lobe were retracted and the anterior Circle of Willis and the optic chiasm were exposed and inspected. The rod was noted to have not injured any neurovascular structure in the region. It was located just in front of the anterior communicating artery. The metal rod was dissected free and pulled out under direct visualization from below. The defect in the dura over the skull base was covered with flap of fascia and sealed with tissue glue. Patient made a good recovery post operatively and did not suffer from any complications.

DISCUSSION

The consequence of a penetrating injury to the brain by a projectile is determined by a number of characteristics. The first factor to take into consideration is the velocity of the projectile. Laws of physics dictates that the kinetic energy contained within a projectile is directly proportional with the velocity of the said item. The higher the velocity the greater the damage to the surrounding tissue by transfer of this kinetic energy to the target. This is exemplified by gunshot injuries.

The penetrating injuries described in this review were generally of low velocity. These types of injury do not cause concentric zones of cavitation and necrosis like that seen in high velocity penetrating injuries. Injury is predominantly restricted locally along the line of injury.

When a projectile penetrates the brain and its covering layers, a communication is created between the intracranial compartment with the external environment that significantly increases the risk of leakage of cerebrospinal fluid and infection. Intracranial abscess may occur up to

months after the injury. The incidence of infective complications significantly increase if bone fragments are retained in the wound [3]. This highlights the reason why penetrating injuries should be debrided in a thorough manner intraoperatively and the patient given a long course of antibiotics. The site of the penetrating injury might be considered as an influential factor in the severity of the injury with injury affecting more important sites naturally having a poorer outcome.

The management principles of patients with this type of injury are similar to that governing any other form of head injury. However some additional aspects are; that it may be inappropriate to remove any protruding part of the foreign body until the patient is in the operating room, unless it cannot be avoided. The protruding object should also be stabilized during evaluation and transportation to prevent further injury. Some authors have even suggested having another identical object for comparison in planning extrication of the embedded object.

The goals of surgical intervention in patients with these injuries are to:-

1) Remove the penetrating item from the brain parenchyma
2) Remove necrotic tissue, debris and other potential contaminants
3) Evacuate of any haematomas occurring from the injury and secure haemostasis.
4) Ensure watertight closure of the dura to prevent CSF leakage.

All three cases that were described in this review are those with penetrating projectiles protruding out from the injured surface. Despite the seemingly daunting appearance of these injuries to the treating physician, treatment should proceed in a systematic manner as described above. We choose to highlight the first case as it was important to note that the nail should not simply be pulled out of its penetration site on impulse. A wide craniotomy had to be fashioned so that proximal and distal control of the superior saggital sinus could be done prior to removing the nail. Although the imaging revealed no intracranial bleeding, there is still a possibility of an injury of the sinus being present.

Furthermore,the slightly angulated nature of this projectile also could result in sinus injury during removal leading to massive exsanguinations which could be particularly dangerous for a child. Thus direct visualization and means for control of haemorrhage were warranted in this case.

In the second case, a motorcycle kick-starter had penetrated the skull base in the frontobasal region. A frontal craniotomy was fashioned allowing the projectile to be freed from above while evacuating associated contusions that had occurred. Once dissected free from the surrounding structures, the projectile was pulled out through the initial trajectory of injury. In this case care was taken not to oscillate the projectile in order to allow it to come free from the structures to which the trauma had impacted it. This is vital so that no further injury would occur.

In the last case the penetrating injury also occurred in the frontobasal region but in the midline. The proximity of the tip of the projectile to structures of the anterior Circle of Wwillis and its branches as well as the optic chiasms made its necessary to expose vital neurovascular structures in the region before any attempts were made to remove the penetrating object. Once again, although initial scans revealed no evidence of haemorrhage, injury to a strucuture in the anterior circle of willis and its branches can still occur and this is exemplified in literature from the occurrence of delayed subarachnoid haemorrhage due to aneurysm forming months after the traumatic event occurs. Removal of the metal rod also had to be done under direct vision to prevent any further injury as well.

Following surgical removal of the penetrating item, the patient should be given prolonged course of antibiotics in view of the high risk of infective complications. In some patients, depending on the site of puncture, a delayed cerebral angiography should also be considered to detect traumatic aneurysm of the intracranial vessels caused by the penetration

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