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CASE ILLUSTRATION WITH REVIEW

Penetrating skull fracture by a wooden object: Management dilemmas and literature review

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ABSTRACT

Most penetrating skull injuries are caused by gun shot wounds or missiles. The compound depressed skull fracture represents an acute neurosurgical emergency. Management and diagnosis of such cases have been described, but its occurence following a fall onto a piece of wood is quite unusual. A 75-year-old female fell onto a piece of wood that penetrated her skull on the left frontal region and was treated in our department. The patient had no neurological deficits during presentation. She was managed surgically and removal of the wooden object was performed to prevent early or late infection complications. Wooden foreign bodies often pose a different set of challenges as far as penetrating injuries to the brain are concerned. Radiological difficulties and increased rates of infection due to its porous nature make these types of injuries particularly interesting. Their early diagnosis and appropriate treatment can minimize the risk of complications.

Key words: Penetrating injury, skull fracture, wood object

Introduction

Skull fractures are one of the most common cases following road traffic accidents, falls, assault and other head injuries. They are classified into three types: linear, depressed, and comminuted type. A depressed fracture is one of the most common penetrating injury. It is caused by bone fragments driven into the brain or its coverings during severe impact head injury. Computed tomography (CT) scan imaging with a wide window setting is sufficient and necessary to differentiate the bone fragments from the underlying clot or cerebral contusion.[1,2]

Case Report

A female 75-year-old farmer, while working in her field, accidentally fell onto a piece of wood that pierced through her skull [Figure 1] and was directly brought to our emergency department about 8 hours following the alleged trauma. She was conscious throughout the incident with a brief history of vomiting but no seizure episode was present. During admission, her Glasgow coma scale (GCS) was 15 with both pupils equal and reactive. A large open wound at her left frontal region size 5×4 cm with a penetrating wood was visible.

A CT scan of her brain was performed emergently. The bone window CT demonstrated bone fragments penetrating her brain with underlying hematoma [Figure 2a and b]. Upon completion of all the necessary diagnostic studies, she was taken promptly to the operating room.

Patient was positioned supine with her head slightly turned to the right. The same wound was used as one of the margin of a 'S' shape incision and scalp flap was retracted. On raising the flap, a large wooden object size 4×3 cm was found piercing the bone and surrounding tissue. A craniotomy was undertaken using four burr holes surrounding the object for better operative exposure [Figure 3a]. During careful removal of the object, dural tear size 3×2 cm was found. We carefully performed necrotic tissue debridement and removal of bone fragments piercing the brain matter [Figure 4]. There was significant bleeding during hematoma evacuation which was effectively controlled using gel foam and pressure. Wound was irrigated with saline and gentamicin antibiotic. The dural defect was then covered with autologous graft [Figure 3b].

This surgical procedure was considered as a successful surgery. The patient was allowed to be awakened from general anesthesia in the operating room. Post operative recovery

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was good and patient was discharged on the tenth day after the surgery. During 3-month follow-up, patient is doing well without any neurological deficits.

Discussion

Depressed skull fractures have presented medical and cultural problems to human society since its antiquity. According to the Edwin Smith Surgical Papyrus, ancient Egyptians realized the grace nature of skull fractures. A skull fracture results when an immense energy source is exerted to the head. There are several parameters in classifying skull fractures.

Figure 1: Pre-operative open wound over left frontal region

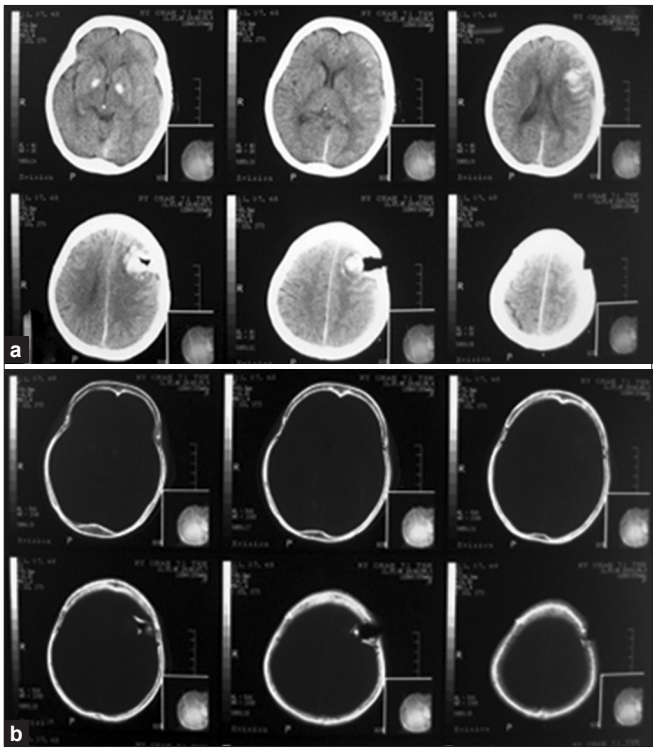

Figure 2: (a) Brain CT scan revealing a large depressed fracture over left frontal region; (b) Brain CT scan with bone window to confirmed a large depressed fracture over left frontal region

The severity and complexity of the fracture depends on the amount of energy (force) exerted, the angle of exertion, the shape of the object delivering the force, and the anatomical portion of the calvarium struck. Numerous fracture patterns have also been described such as; linear, stellatte, distatic, and comminuted.[2-5]

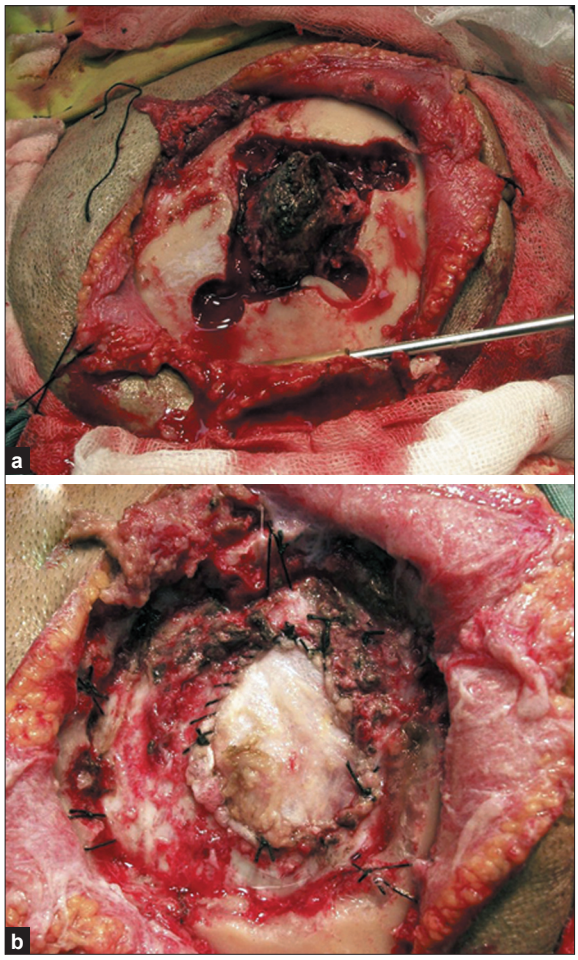

Figure 3: (a) Exposure of the wooden object after craniotomy; (b) Post-operative; the duramater defect was closed with graft

Figure 4: A wooden object after debridement

The medical literature has estimated depressed skull fracture occurance at an annual rate of 20 to 60 per 1 million, although this statistics varies widely among countries. Almost three quarter of these depressed skull fractures are located in the frontal or parietal bones. The majority of depressed skull fractures are open and often have dural lacerations in addition to cortical injury. The rate of associated neurological injury is higher in cases of depressed skull fractures than in cases of nondepressed skull fractures.[3,5]

Penetrating injuries of the skull and brain are relatively uncommon wounds, that represent about only 0.4% of all head injuries. While most penetrating injuries in Western countries are caused by gun shot wounds, interestingly, this is quite different in developed and third world countries. There is a variety of nonmissile penetrating injuries that can occur with weapons ranging from knifes, scissors, pencils, etc. All of these injuries are defined as wounds that involve a smaller area with relatively low velocity impact.[6] Most penetrating skull injuries, regardless of the size of the penetrating bodies, are rarely associated with major neurological symptoms, except in high velocity injuries. In this case, a large amount of kinetic energy contact with the skull and the force probably acts for a shorter time which causes local deformation resulting in penetration and skull fracture.[3,5,6]

Early diagnosis and appropriate treatment of compound depressed fractures of the skull can minimize the risk of complications. Once physiologic stability has been ensured, laboratory and radiological evaluations are vital in determining the extent of injury. Radiographic assessment may consist of a CT scan, skull series, angiography, and magnetic resonance imaging. CT scans can detect the path and location of the embedded foreign body, bone or metal debris fragments and the extent of intracranial damage.[2-4,7]

Antimicrobial agents have markedly decreased the rate of infections since their introduction. Penetrating injuries to the brain are associated with a high risk of secondary infection due to the biological debris, such as; skin, hair, wood, and fibres that are carried in. Abscess should be carefully excluded if there has been any delay in patient management or if neurological deficit occurs over time after the initial injury. Complications of late seizures are likely to occur in patients suffering with seizures and or amnesia during the first week of injury. Patients presenting with dural laceration and or associated intracranial hemorrhage are also at risk for developing late seizures and should be treated for at least six months.[2,3,5,8]

Some of the possible infectious complications that might occur are scalp cellulitis, subdural abcess formation, osteomyelitis, epidural empyemas, subdural empyemas, meningitis, ventriculitis, cerebritis, and brain abcess. According to Miller *et al*, cerebral abcess was the most common intracranial lession which is 48% cases of compound depressed fracture.[9]

There were only 13% intracranial infections from which a specific organism was isolated and the majority of these were *Staphylococcus aureus* species. The early need of broad spectrum antibiotics administration is recommended. Intraoperative cultures should be obtained, and proper antibiotics should be initiated once the positive cultures have been obtained.[2,4] We treated our patients with third generation of cephalosporin and, interestingly, the intraoperative culture turned out negative.

Penetrating skull injury caused by a wooden object presents a significant problem with regard to infection rates of central nervous system (CNS) and its radiographic identification. Miller *et al*, demonstrated a 72% morbidity rate of 42 cases of penetrating transorbital brain injury caused by a wooden object, described as permanent neurological deficit such as cranial nerve palsies and motor dysfunction.[9] The mortality rate in the post antibiotics period was found to be 25% and was most often related to infectious events.[9] The wood-fragments might vary from large to microscopic particles, hence, its softness and porosity will assist in the transfer of bacteria both from wood-objects and patient's skin into the wound. There were 37 case reports of intracranial wood confirmed during operation or autopsy, in which 92% of these cases had no initial suspicion of retained fragments.[2]

Intracranial wooden foreign bodies due to transorbital penetrating injuries are relative rare; Nishio *et al*., reviewed 23 reported cases of duramater penetration by pointed wooden objects including bamboos and petridophytes confirmed by neuroradiological examination or surgery in the last 20 years.[10] Of 23 patients reviewed, 16 patients (70%) were complicated by central nervous infection and 12 patients (52%) were complicated by brain abscess, and 3 patients died (13%).[11-13] Most of the reports stated that the intracranial retained wooden foreign bodies frequently caused delay infectious complications and hence surgical removal is deemed necessary even in the absence of symptoms.

Birch-Hirshfield reviewed 30 cases of tetanus secondary to transorbital injuries and 14 cases among them involved wooden objects. There was a 67% mortality rate in the patients who developed tetanus infection stressing the importance of tetanus immunization as required.[14] Another troublesome characteristics of wood is that it has a radiodensity quite similar to soft tissue and brain. This makes small fragments very difficult to detect radiographically. But in some cases, using contrast may help to distinguish a wooden fragment from fat or air by the presence of rim enhancement around the fragment.

Early surgical exploration is likely to be successful in cases of retained foreign bodies. Different approaches can be chosen depending on the location of the fragment. We believe that after adequate resuscitation, the goal of surgery is safe removal of the foreign body followed with careful debridement without

causing further damage to the brain tissue.[5,7,8] Effective management of penetrating skull injury with foreign objects necessitates an understanding of the mechanism of injury and associated neurological pathophysiology. This remains an acute neurosurgical emergency which is best treated with early debridement and use of adequate antibiotics.

Conclusion

Herewith, we report a case of penetrating skull injury caused by a wooden object. Wooden foreign bodies often pose a different set of challenges as far as penetrating injuries to the brain are concerned. Radiological difficulties and increased rates of infection due to its porous nature make these types of injuries particularly interesting. Their early diagnosis and appropriate treatment can minimize the risk of complications.

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