Reverse-Penetrating Head Injury Caused by Falling on Sharp-Edged Stone: A Case Report

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Abstract

Penetrating injury is usually caused by a traumatizing object when it moves from its place of rest—that is, fired from a weapon, falls from the height, hurled from hand, or flown by wind—to reach and penetrate the static subject. These injuries are potentially life threatening, which can occur in military as well as in civilian societies. However, a case of reverse-penetrating cranial injury was encountered, when a 4-year-old male child fell from height, hitting his head against sharp-edged stones on the ground. The parts of the stones were retained in the epidural space after fracturing the cranial vault and were undetected by CT scan head. Thus, reversely, the subject moved toward the static object and caused injury. The medicolegal implications of such a trauma are high in a geographical region where mobs and police resort to stone pelting.

Keywords
- reverse-penetrating head injury
- undetected stone
- medicolegal implications

Introduction

Although head injuries are commonly caused by the accidental trauma in all the age groups, penetrating trauma is uncommon. For practical reasons, a wound, in which the projectile breaches the cranium but does not exit, is described as penetrating, and an injury in which the projectile passes through and leaves both entrance and exit wounds is described as perforation.[1] This distinction has clear prognostic implications as penetrating head injuries are less damaging than perforating injuries. Similarly the penetrating injuries of high velocity (war injuries) are more catastrophic than low-velocity (civilian injuries) types.[2] Most of the civilian injuries are penetrating cranial wounds of low-velocity types that include nonmetallic and metallic missiles such as sharp-edged stones fired from catapult and slingshots and teargas shells.[1,3] Usually in penetrating injuries the object moves toward the subject causing the injury; however, reverse can also occur by falling, running, or flying. A reverse-penetrating injury has legal implications in areas where stone pelting is common by the uncontrolled mobs.

Case Report

A 4-year-old male child was brought into the emergency services of neurosurgery department with a history of fall from height on a heap of sharp-edged stones and bleeding from head. However, on examination, the child was alert and fully conscious with a heart rate of 110 beats/min and blood pressure of 110/70 mm Hg. The Glasgow Coma Scale (GCS) score on admission was 15/15. The pupils were normal in size and reacting to light when child was undisturbed. There was a lacerated and bleeding wound of 2.5 cm $\times$ 3 cm on the right parietal area. A cephalhematoma was located just 3 cm above and 2 cm behind the bleeding wound. There were no other visible body injuries. After initial resuscitation, the patient was investigated. The complete blood chemistry was normal. The roentgenogram of the chest and cervical spine, the focused abdominal sonogram for trauma (FAST) were also normal. However, the roentgenogram of the skull on anteroposterior (AP)/lateral views revealed two closely placed radio-opaque shadows in the right posterior parietal area, which were thought to be overlapped shadows of fractured and depressed bones

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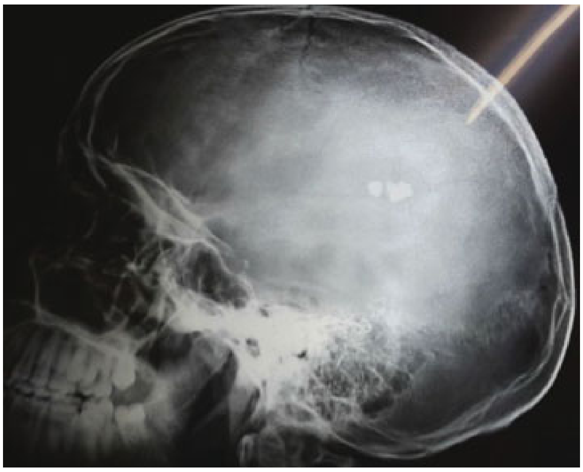

Fig. 1 X-ray skull—lateral view shows double radio-opaque shadows in the parietal area, which were mistaken for overlapping of the broken bones in the depressed skull fracture.

(►**Fig. 1**). The CT (computed tomography) scan of the head revealed a depressed fracture of the right posterior parietal bone with in-driven bone fragments. There was another depressed fracture located posterosuperior to the anterior one. There were no intracranial hematomas or contusions; however, a small air bubble was detected under the fractured bone. The basal cisterns were normal and no midline shift was found (►**Fig. 2**). The patient was prepared and explored in emergency operating room. A right posterior parietal skin flap was raised, covering the lacerated wound as well as posterior cephalhematoma site. The double depressed fractures were identified. While the depressed bone was being elevated, there appeared two small (10 mm × 8 mm) broken grayish stones coated with blood and hairs in the anteroinferior depressed fracture over the dura (►**Figs. 3** and **4**). Although dura was partially torn, but no cortical injury or cerebrospinal fluid (CSF) leak appeared there. Both sites of depression were debrided and saline washes given to clean the bone fragments, hairs, and dirt. The hemostasis was achieved. A subgaleal negative suction drain was placed and wound closed. The intra- and postoperative period was uneventful. The patient was put on antibiotics. The patient was discharged on the third postoperative day without any deficit and a GCS score of 15/15. The patient was seen 1 week after in the OPD.

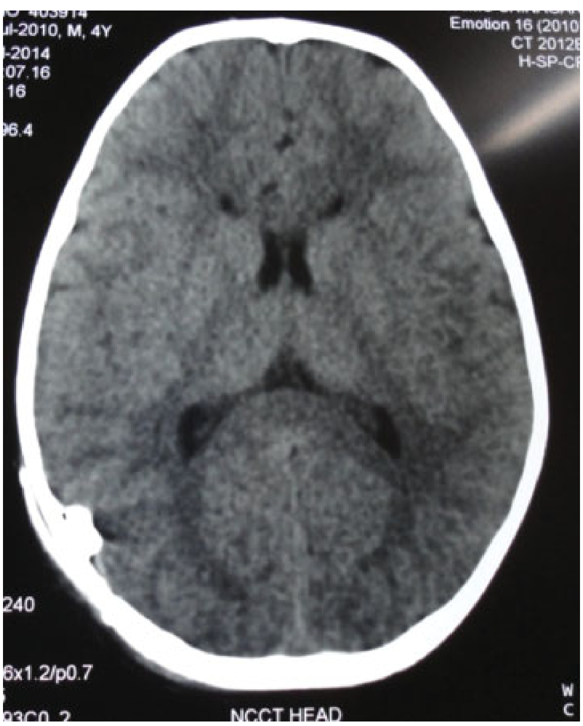

Fig. 2 Plain CT scan head shows right parietal depressed fracture with in-driven broken stones mistaken for bone pieces.

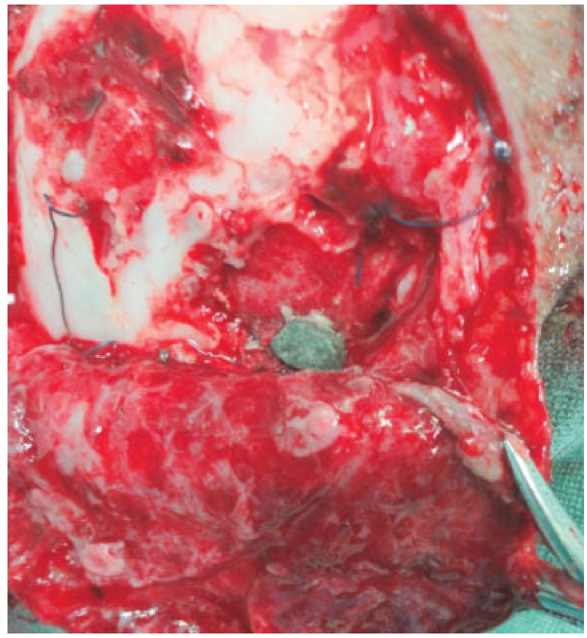

Fig. 3 Intraoperative photograph showing two depressed fractures with a part of a broken stone in it.

Discussion

The penetrating head injuries have higher mortality and morbidity than blunt trauma even in civilian set up. The most penetrating cranial injuries worldwide are caused by

Fig. 4 Clinical photograph of the two broken and retained stone pieces.

missile injuries, notably gunshots and shrapnels. Similarly most penetrating nonmissile craniocerebral injuries are caused by cutting instruments and objects such as stones, sharpened wooden sticks, screwdrivers, nails, spikes, iron rods, arrows, pencils, ice picks, chopsticks, umbrella ends, sewing needles, and garden forks.[2,4,5] The nonmetallic missile injuries are probably the most contaminated penetrating injuries due to their vegetative and infective nature.[6] The pathophysiology of penetrating head injury depends on the kinetic energy and trajectory of the object through the brain. The principle of missile injuries is that low-velocity missile results in less damage in contrast to the high-velocity missile that causes extensive damage by cavitation and the rapid transfer of kinetic energy into surrounding tissue.[1] However, in the reverse-penetrating injuries, it is the potential energy of the falling brain, or brain in acceleration as in road traffic accidents, which gets transformed into the kinetic energy just before the impact. The impact force is equal to the energy gained by the falling brain divided by the distance traveled by it after the impact. The impact on a human body can be difficult to determine as it depends on how the body hits the ground or like which part of the body first touched the object and the angle of the falling body and were the hands used to protect the body and so on. Also, the degree of permanent neurologic damage depends on severity of primary and secondary injury, location of brain injury (eloquent or noneloquent cortex), and duration from the time of injury to operative intervention (early vs. delayed) etc. *Because a falling human body or any part of it (brain) is in no way able to achieve a velocity of even a "piercing stab thrust" leave alone that of a low-velocity missile, the morbidity and mortality in a reverse-penetrating injury may not amount to a penetrating type of injury. However, the weight of the falling body is a significant factor for the impact force leading to the severity of the brain damage. Moreover, the depth of penetration and infective nature of the penetrating object also account for the primary brain damage, immediate and delayed complications*. The present case of reverse-penetrating injury had retained undetected broken-stone pieces. There was no suspicion of a stone being retained because of the hardness of object against which the head had struck and also the absence of any streak artifacts on the CT scan. Though least reliable in the present day, the X-ray skull revealed radio-opaque shadows and foreign-body nature of shadows retrospectively, thus still maintaining their value and importance if not equivalent to the CT scan. Moreover, in cases of retained metallic missiles where quality of CT scans are spoiled due to the artifacts, X-rays play a valuable role. The medicolegal implications of such injuries are high in geographical areas such as North India, Middle-East etc., where stone pelting by agitated mobs is common. *The head injury due to a flying stone results mostly in mild scalp injury, but severe skull fractures of linear or depressed types leading to underlying brain injury might occur. The stone in itself is never retained as it never penetrates. This differentiates it from head injuries due to a forceful fall on a stone that may be retained, penetrating missile injuries and dynamic road traffic injuries that may cause scalp, skull, and brain damage of equal magnitude. This is very significant medicolegally*. The complications of such injuries include in-driven cerebral stone or bone retention, contusions, CSF leaks and fistulas, intracerebral hematoma, subdural and epidural hematomas, subarachnoid hemorrhage, pneumocephalus, skull fractures, cerebral edema, etc. The infectious complications include brain abscess, encephalitis, meningitis, and scalp sepsis. The vascular complications such as pseudoaneurysms and posttraumatic arteriovenous malformation, though rarely, can occur following penetrating trauma.[7,8] The optimum management of penetrating brain injury (PBI) requires adequate understating of mechanism and pathophysiology of injury. Based on the current evidence, it is mandatory to have all modalities of computed tomography scanning such as bone windows and 3D/spiral CT as the neuroradiologic modality of choice for PBIs. The cerebral angiography is recommended in patients with PBIs, where there is a high suspicion of vascular injury due to a missile track crossing a basal or vital vascular complex. It is still debatable whether craniectomy or craniotomy is the best approach in patients with PBI. The goals of surgery include hemostasis, debridement to reduce the intracranial pressure (ICP) and the infections after wound closure, evacuation of a clot causing mass effect or midline shift, and repair of dura and scalp hemostasis.[9] The CSF leaks are common in patients with PBI and surgical correction is recommended for those that do not close spontaneously or are refractory to CSF diversion through a ventricular or lumbar drain. The risk of posttraumatic epilepsy after PBI is high, and therefore the use of prophylactic anticonvulsants is recommended. The worst outcome in PBI is correlated to the advanced age, suicide attempts, associated coagulopathy, low GCS score of 3 with bilateral fixed and dilated pupils, and high initial ICP.[10]

Conclusion

While the head is in acceleration, a static nonmetallic penetrating object can be retained and shall remain undetected by routine radiology, for the lack of remarkable artifacts that are only created by the metallic foreign bodies on the CT scan. The X-rays are sometimes doubly valuable especially in detecting nonmetallic foreign bodies as well as in solving the medicolegal cases in disturbed areas where public and police both indulge in stone pelting.

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