Penetrating head injury

A penetrating head injury, or open head injury, is a head injury in which the dura mater,is breached.

A penetrating head injury involves “a wound in which an object breaches the cranium but does not exit it.”

In contrast, a perforating head injury is a wound in which the object passes through the head and leaves an exit wound.

Epidemiology

Although high-velocity penetrating brain injury is often reported, reports of low-velocity, combined head and neck penetrating injury are rare [1)].

Penetrating brain injury in civilians is much less common than blunt brain injury but is more severe overall.

Penetrating head injuries are rare especially in the paediatric age group. Relatively minor falls over common household objects can cause potentially life-threatening brain injuries.

Household objects like electrical plugs may constitute a risk for children. It may be worthwhile to reconsider the design of electrical plugs [2)].

Penetrating intracranial injuries are common in the deployed military medical environment. Early assessment of prognosis includes initial conscious level.

Etiology

A penetrating injury can be caused by high-velocity projectiles or objects of lower velocity such as knives, or bone fragments from a skull fracture that are driven into the brain. Head injuries caused by penetrating trauma are serious medical emergencies and may cause permanent disability or death.

Classification

The penetrating traumatic intracranial injury can be divided into gunshot wounds or stab wounds based on the mechanisms of injury.

Pediatric penetrating intracranial injury are of major concern as many parental and social factors may be involved in the causation.

Intracranial gunshot wound.

Low-velocity penetrating brain injury

Penetrating non missile intracranial injury.

Transnasal penetrating intracranial injury.

Transoral penetrating intracranial injury.

Treatment

There is controversy regarding the utility of antimicrobial prophylaxis in managing such patients, and if so, which antimicrobial agent(s) to use.

Although a review of the literature did not reveal any benefit, there institutional series suggested that patients with pTBI may benefit from prophylactic antibiotics. They proposed a short antibiotic course with a regimen specific to cases with and without the presence of organic debris [3)]

Outcome

see Penetrating head injury outcome.

Case series

2017

1086 patients with head CT scans performed and ICU admission orders were reviewed. After exclusion criteria were met, 347 patients with isolated TBI were analyzed-99 (29%) with penetrating-TBI and 248 (71%) with blunt-TBI. Patients with p-TBI had a higher mortality (41% vs. 10%, p<0.0001) and a greater incidence of coagulopathy (64% vs. 51%, p<0.003). After dichotomizing p-TBI patients by mortality, patients who died were younger and were more coagulopathic. When adjusting for factors available on ED arrival, coagulopathy was found to be an early predictor of mortality (OR 3.99, 95% CI 1.37, 11.72, p-value=0.012).

This study demonstrates that p-TBI patients with significant coagulopathy have a poor prognosis. Coagulopathy, in conjunction with other factors, can be used to earlier identify p-TBI patients with worse outcomes and represents a possible area for intervention [4)].

2015

Penetrating orbital-cranial injuries (POCIs) are difficult cases especially in hospitals in low-middle-income countries (LMIC) where resources are limited.

A total of 30 patients with penetrating orbital injuries were admitted from March 2011 to December 2011. Of this group, only four patients were diagnosed with cranial penetration. Computed tomography (CT) angiography revealed orbital fractures and injury to frontal, temporal, or occipital lobes. Urgent craniotomy with isolation of ipsilateral carotid artery was performed. GOS score at discharge was 5 in three patients and 4 in one patient. POCIs are not uncommon in hospitals of LMIC.

In such scenarios, a standard approach with CT angiography and early neurosurgical intervention results in good outcome [5].

2013

813 patients sustained a penetrating head injury, of whom 625 were injured by blast fragmentation and 188 were injured by intracranial gunshot wound (GSW); overall 336 patients (41.3%) died. There was a significant difference between survival from GSW (41.5%) and blast fragment (63.8%; p<0.001). In addition, the GCS in patients injured by GSW was significantly lower than that in patients injured by blast fragment. 157 cases sustained isolated head injury (79 GSW, 78 blast). The difference in injury severity between these groups was marked; median abbreviated injury scale (AIS) was higher in the GSW group, survival lower (42% vs. 88%; p<0.001) and distribution of GCS categories less favourable (p<0.001). 338 of 343 patients (98.5%) with a best recorded GCS>5, survived to discharge.

Most patients who present following penetrating intracranial injury, who have a GCS>5, survive to discharge. There is a significant difference in survival to hospital discharge following penetrating injury caused by blast fragment compared to those caused by GSW, partly attributable to a difference in injury severity [6].

Case reports

Two cases of patients with psychotic depression who attempted suicide by hammering nails into their heads. On imaging, deep penetration within the brain parenchyma was noted; however, neither case had any neurological deficit or symptoms attributable to brain trauma.

Conclusions: Self-inflicted penetrating brain injuries with peculiar objects such as nails are rarely encountered in practice. They need prompt management for their removal and addressing the underlying mental health illnesses [7].

A penetrating head injury caused by a household electrical plug in a 6-month-old child. The two rounded pins of the plug were embedded in the posterior parietal area of her head, very close to the cranial midline. There was no neurological deterioration or bleeding. Radiological investigation showed a depressed skull fracture underneath the two pins. One of them came very close to the superior sagittal sinus but there was no evidence of intracranial bleeding. The electrical plug was extracted under general anaesthesia in the operating theatre. The penetrating fracture segments were removed. The sagittal venous sinus was fortunately undamaged.

Household objects like electrical plugs may constitute a risk for children. It may be worthwhile to reconsider the design of electrical plugs [8].

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Li L, Li H, Yang K. Multidisciplinary Team Treatment of Penetrating Head and Neck Trauma. J Craniofac Surg. 2016 Jul 13. [Epub ahead of print] PubMed PMID: 27428914.
2)
López González A, Gutiérrez Marín A, Alvarez Garijo JA, Vila Mengual M. Penetrating head injury in a paediatric patient caused by an electrical plug. Childs Nerv Syst. 2006 Feb;22(2):197-200. Epub 2005

Jun 1. PubMed PMID: 15928968.

3)

Ganga A, Leary OP, Sastry RA, Asaad WF, Svokos KA, Oyelese AA, Mermel LA. Antibiotic prophylaxis in penetrating traumatic brain injury: analysis of a single-center series and systematic review of the literature. Acta Neurochir (Wien). 2022 Dec 19. doi: 10.1007/s00701-022-05432-2. Epub ahead of print. PMID: 36529784.

4)

Folkerson LE, Sloan D, Davis E, Kitagawa RS, Cotton BA, Holcomb JB, Tomasek JS, Wade CE. Coagulopathy as a predictor of mortality after penetrating traumatic brain injury. Am J Emerg Med. 2017 Jul 5. pii: S0735-6757(17)30508-9. doi: 10.1016/j.ajem.2017.06.057. [Epub ahead of print] PubMed PMID: 28764996.

5)

Estebanez G, Garavito D, López L, Ortiz JC, Rubiano AM. Penetrating Orbital-Cranial Injuries Management in a Limited Resource Hospital in Latin America. Craniomaxillofac Trauma Reconstr. 2015 Dec;8(4):356-362. Epub 2015 Feb 20. PubMed PMID: 26576244.

6)

Smith JE, Kehoe A, Harrisson SE, Russell R, Midwinter M. Outcome of penetrating intracranial injuries in a military setting. Injury. 2013 Dec 17. pii: S0020-1383(13)00575-5. doi: 10.1016/j.injury.2013.12.004. [Epub ahead of print] PubMed PMID: 24398079.

7)

Shaukat S, Zaidi SMF, Khatri A, Siddiqui MS, Khulsai MS, Ansari AB, Ayesha S, Khan AA, Imran M. Self-inflicted penetrating brain injuries with preserved neurological function: a case series. Chin Neurosurg J. 2023 May 25;9(1):15. doi: 10.1186/s41016-023-00328-1. PMID: 37231518; PMCID: PMC10210394.

8)

López González A, Gutiérrez Marín A, Alvarez Garijo JA, Vila Mengual M. Penetrating head injury in a paediatric patient caused by an electrical plug. Childs Nerv Syst. 2006 Feb;22(2):197-200. Epub 2005 Jun 1. PubMed PMID: 15928968.