Low-velocity penetrating brain injury

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A low-velocity penetrating brain injury refers to a traumatic injury to the brain caused by a relatively slow-moving object. This type of injury often occurs due to accidents, assaults, or self-inflicted wounds where an object penetrates the skull and enters the brain tissue. The velocity of the penetrating object is considered low compared to high-velocity injuries such as those caused by bullets or shrapnel.

Low-velocity penetrating brain injuries can still cause significant damage to the brain tissue due to direct trauma and potential disruption of vital structures. The severity of the injury depends on various factors including the size and shape of the penetrating object, the area of the brain affected, and the extent of tissue damage.

Review

A review of published LVPBI cases over the past 20 years demonstrated that most cases (55.2%) are due to accidents. Of patients undergoing surgery, 43.4% underwent a craniotomy, and 22.8% underwent a craniectomy. Despite the grave nature of LVPBI, only 13.5% of the patients died. Additionally, 6.5% of patients developed an infection over their clinical course.

In all, more reported cases further paint a picture of the current state of management and outcomes regarding LVPBI, paving the way for more cohesive guidelines to ensure the best possible patient outcomes [1)].

Treatment

Treatment for low-velocity penetrating brain injuries typically involves urgent medical intervention to stabilize the patient, control bleeding, prevent infection, and minimize further damage to the brain tissue. Surgery may be necessary to remove the penetrating object, repair damaged blood vessels, and alleviate pressure on the brain. Rehabilitation and long-term care are often required to help patients recover function and manage any lasting neurological deficits.

Case series

Three adults and five children were admitted to the neurosurgical ward, SMS Hospital, Jaipur, during 1995-2006. The patients were timely operated by standard operation procedures. The most commonly encountered types of penetrating head injuries are industrial accidents, suicidal attempts, and criminal assault. Two patients suffered from assault, one of them had a self-inflicted injury in suicidal attempt and four were accidental. We have included only those cases that presented to us with impacted weapons in situ. We used intravenous Ceftriaxone and Gentamycin as prophylactic antibiotics in all cases. Phenytoin was used as a prophylactic anticonvulsant in the cases where cerebral cortex injury was seen.

In the context of earlier reviewed cases and from our own experience, we learned that removal of impacted sharp weapons should only be done in the operation theatre to avoid further brain damage. Removal of the foreign object is in the direction of trajectory without zig-zag movements. The skin incision was made S-shaped around the site of entry of the weapon. Plain radiographs of the skull and preferably CT scan should be performed to ascertain the direction of the trajectory of the weapon.

Low-velocity penetrating head injury injuries in developing countries like India are not uncommon and are usually seen in rural setups mainly because of interpersonal assault. The extent of damage to tissues depends on the type, shape, size, site, and the velocity of sharp weapon as well as on the extent of its penetration at the impacted site. X-ray skull is essentially done to assess the location and the nature of the injury, the driven bone fragment, and the foreign body within the brain. The CT scan helps in the visualization of the entire head, the nature of the intracranial injury, hemorrhage, edema, a tract of lesion, intracranial bony and metallic fragments, and intracranial air. Craniectomy around the foreign body, debridement, and removal of the foreign body without zigzag motion are needed [2)].

Case reports

Cook et al. report an illustrative case of a 29-year-old female with a dense, plastic spike penetrating her right orbit and into her midbrain. After assessment with a CT scan and angiography, the object was removed with careful attention to possible vascular injury. The patient had an uncomplicated post-operative course and received antibiotic and antiepileptic prophylaxis. She was discharged on postoperative day 5, experiencing only mild left-sided weakness.

Common concerns regarding LVPBI include infection, post-traumatic epilepsy, and vascular injury. A review of published LVPBI cases over the past 20 years demonstrated that most cases (55.2%) are due to accidents. Of patients undergoing surgery, 43.4% underwent a craniotomy, and 22.8% underwent a craniectomy. Despite the grave nature of LVPBI, only 13.5% of the patients died. Additionally, 6.5% of patients developed an infection over their clinical course.

In all, more reported cases further paint a picture of the current state of management and outcomes regarding LVPBI, paving the way for more cohesive guidelines to ensure the best possible patient outcomes [3)].

A 10-year-old boy was shot in the head with a harpoon. Computed Tomography Angiography (CTA) demonstrated that the harpoon punctured through the jugular foramen and had a high probability of internal jugular vein (IJV) and internal carotid artery (ICA) involvement. The surgery was performed seven days after injury in a hybrid operating room (OR). They used an intraoperative digital subtraction angiogram (DSA) to guide the decision to permanently occlude the IJV and ICA. The patient had a good postoperative recovery and was sent home after three weeks of observation in the hospital.

Despite the high cost, intraoperative cerebral angiography in hybrid theatre for selected patients with penetrating brain injury where major blood vessel damage is anticipated might benefit overall patient outcome. [4].

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[1], [3]

Cook R, Zima L, Khazaal J, Williams J. Low-velocity penetrating brain injury: a review of the literature and illustrative case. Brain Inj. 2024 Mar 31:1-7. doi: 10.1080/02699052.2024.2336067. Epub ahead of print. PMID: 38555515.

[2]

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[4]

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