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CASE REPORT

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Penetrating Brain Injury through a Pre-existing Skull Defect: Case Report

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ABSTRACT

Introduction: *Penetrating brain trauma represents about 0,4% of traumatic brain injuries. In the literature, there is a number of case studies and case-series on non-missile penetrating injuries management, but reports on penetrating brain injuries through a craniectomy are lacking.*

Case presentation: *A 44-year-old male was transferred to the Emergency Room in a comatose state after being stabbed on the head by a sharp object at an area where a previous decompressive craniectomy took place years ago. Computed tomography of the head showed an extensive intracerebral hemorrhage with intraventricular extension and diffuse subarachnoid bleeding. He was immediately transferred to the operating room for hematoma evacuation and hemostasis. Postoperatively, a slight improvement in his neurological status was initially noted, but the patient's clinical course was complicated by a central nervous system infection. Following a long stay and multiple re-operations, he eventually died due to septic shock and multiorgan failure.*

Conclusions: *Non-missile penetrating brain injuries can be life threatening. Prognosis is dismal in those with pre-existing skull defect and severe brain damage despite aggressive medical and surgical treatment.*

Keywords: penetrating brain injury, non-missile, traumatic brain injury, skull defect.

INTRODUCTION

Penetrating brain trauma, represents about 0,4% of traumatic brain injuries (1) and are further classified into missile and non-missile injuries (2). A subclassification of non-missile penetrating injuries using the criterion of entry point into a natural orifice (orbit, nose, mouth, ear) or the skull has been also suggested (3).

In the literature, although there is a number of case studies and case-series on non-missile penetrating injuries management, no reports on penetrating brain injuries through a craniectomy exist.

We present a unique case of a 44-year-old male who sustained an isolated penetrating head injury caused by a sharp object through a pre-existing skull defect. ❑

CASE PRESENTATION

A 44-year-old male patient was transferred to the Emergency Room after being stabbed on the left side of the head. This region lacked bone

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due to a previous decompressive craniectomy for severe traumatic brain injury. Initial clinical evaluation was noteworthy for Glasgow coma scale (GCS) of 7/15 (E1V1M5) and anisocoria with both pupils unreactive to light. Clinical observation revealed two penetrating wounds in the skin over the bony defect with absence of foreign bodies traversing the surface. Following intubation, he underwent computed tomography (CT) and CT angiography (CTA) of the head, which showed massive intracerebral hemorrhage on the left parietal and frontal lobe in communication with the extracranial surface through the skin wounds. CTA was negative for vascular injury. Significant subarachnoid and intraventricular hemorrhage was also noted (Figure 1). Clinical and radiological examination of the rest of the body was unremarkable. Past medical history was noteworthy for a left decompressive fronto-temporo-parietal craniectomy 11 years ago for traumatic acute subdural hematoma and schizophrenia.

The patient was transferred directly to the operating room. During surgery, multiple penetrating sites were identified in the dura mater. These were further opened in a cruciate manner exposing the underlying edematous brain (Figure 2). Evacuation of the intracerebral hematoma took place accompanied by local debridement and meticulous hemostasis. Dura openings were closed primarily with sutures.

Postoperatively, anisocoria remained, but both pupils became reactive to light. The patient was transferred to the intensive care unit (ICU). Postoperative brain CT scan showed adequate hematoma evacuation and an extra-dural cere-

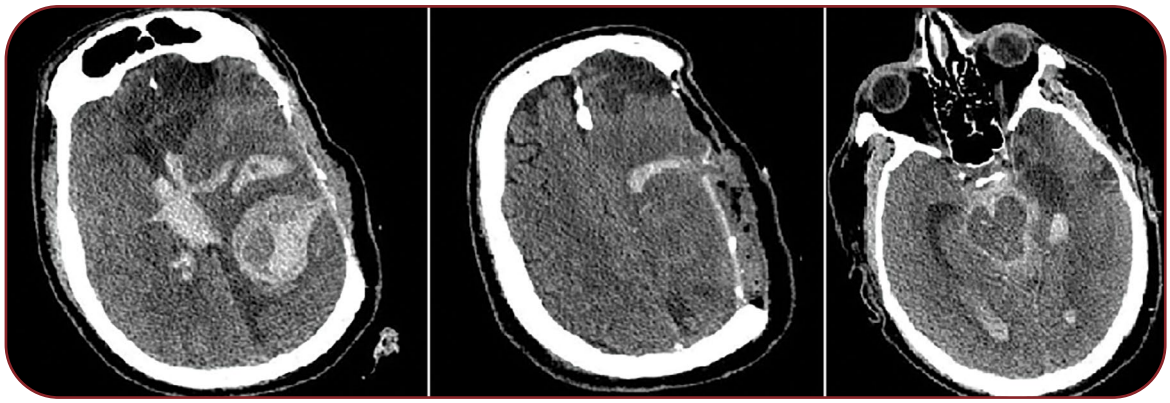

FIGURE 1. Head computed tomography scan on admission showing massive intracerebral hemorrhage with diffuse intraventricular extension and subarachnoid bleeding caused by the stab injury through the pre-existing bone defect – the sites of dural penetration are also visible

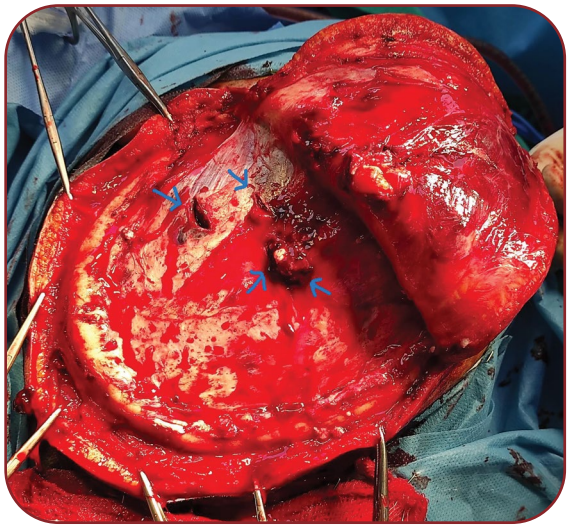

FIGURE 2. Intraoperative image showing the dural penetrations pointed with blue arrows

FIGURE 3. Postoperative head computed tomography scan showing extra-dural fluid accumulation and regression of the intracranial hemorrhage

brospinal fluid (CSF) accumulation, which was managed conservatively (Figure 3).

In the following days, although a slight improvement in his neurological status was initially noted, the clinical course was complicated with CSF leakage from the surgical wound and multiple episodes of fever. Antimicrobial medication was adjusted to meropenem, colistimethate, linezolid and garamycin according to fluid cultures (isolation of *Klebsiella oxytoca*). An external ventricular drainage was inserted. He also developed cerebral salt wasting syndrome (increased urine sodium level accompanied with signs, symptoms and laboratory findings of decreased blood volume) that was successfully managed with intravenous administration of sodium-enhanced fluids. Weaning from the respiratory support was eventually achieved, and the patient was transferred to the neurosurgical department with a tracheostomy, having a GCS of 8NT/15 (E4VNTM4). In the coming days he deteriorated, with resistant fever and respiratory failure, which required re-admission to the ICU. CSF cultures isolated *Acinetobacter baumannii* and *Pseudomonas aeruginosa*. Intraventricular administration of colistin commenced. However, he never recovered and eventually died due to septic shock and multiorgan failure following 47 days of hospitalization. ❑

DISCUSSION

Whenever a non-missile penetrating skull injury is encountered and after primary evaluation and resuscitation (4), initial work-up typically includes plain radiographs in order to depict the penetrating foreign object, its particles, or intracranial bone fragments, while the position of the foreign object can also be visible (1). The next step is head CT scan, which provides useful information for surgical planning but also in depicting intracranial lesions. Computed tomography angiography identifies vascular injuries especially in arteries and venous sinuses (5). Magnetic resonance imaging (MRI) is usually done in case of wooden foreign object (1, 4). Finally, digital subtraction angiography (DSA) can be also considered in the event of vascular injury in particular those not clearly seen on CTA as well as for possible intravascular intervention (4, 6).

Similar to every severe traumatic brain injury, medical management of a severe non-missile penetrating brain injury (NMPBI) should focus on intracranial pressure control, maintenance of optimal brain perfusion with blood and oxygen and prevention of secondary complications (7).

Surgical management of NMPBI must include local debridement of the affected skin, skull, dura and brain parenchyma followed by dura closure, cranioplasty and cutaneous closure (3). Space-occupying hematomas responsible for neurological symptoms and signs should be also evacuated (8). Factors such as entry point, size of foreign object, number of fragments and secondary brain or vascular lesions are also taken into consideration (3, 5). Ideally, surgery for NMPBI should take place within 12 hours, with the most important parameter before surgery being the recognition of possible vascular injury (5). In that case, management should include either preoperative endovascular approach or intraoperative artery control before removal of foreign bodies (5).

Perioperative complications include subdural and extradural hemorrhage, intracerebral hemorrhage and cerebral edema, either localized or diffuse (2, 9, 10). As expected, brain damage secondary to raised intracranial pressure can also have devastating consequences (10). Hypoxic brain damage is a delayed complication occurring mostly in patients with coexistent low systolic blood pressure for a certain amount of time or in those with high intracranial pressure (10, 11).

Infection, such as meningitis, ventriculitis or cerebral abscess, represents a common complication of NMPBI despite antibiotic prophylaxis (12). Risk factors for infection include a long-time interval between ictus and hospital admission, non-administration or false use of antibiotics, retained foreign bodies and inadequate non-viable tissue debridement (4). Administration of broad-spectrum antibiotics covering Gram (+) and Gram (–) bacteria for at least 2-4 weeks is recommended, while adjustment according to cultures is common practice (2, 4). Early surgery and adequate debridement are other measures for infection prevention (5). About 30-50% of patients also develop post-traumatic seizures due to cortical damage. Therefore, prophylactic administration of anti-epileptic drugs is suggested for at least one week (4). Leakage of CSF is not infrequent. This can be prevented with watertight closure of the damaged dura, while a CSF drainage procedure may be deemed neces-

sary as in the current case (4). Finally, vascular complications including carotid-cavernous fistula, pseudoaneurysm formation, vessel occlusion and venous thrombosis have been reported (9).

In the present case, the lack of bone at the site of penetrating object and object removal by the assailant were the major causative factors for the occurrence of complications despite prompt management. The patient developed CSF leakage and a serious CNS infection within the first few days postoperatively that were never controlled even with aggressive antimicrobial medication and CSF drainage.

CONCLUSIONS

Non-missile penetrating brain injuries can be life threatening. Prognosis is dismal in individuals with pre-existing skull defect and severe brain damage despite aggressive medical and surgical treatment. ❑

Conflicts of interest: none declared.

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Statement of ethics: Written informed consent regarding the publication of data and images was acquired by patient's father and sibling. The provided neuroradiological depictions were anonymized to secure patient identity with respect to the General Data Protection European Union Regulation 2016/679. The conduction of the study is in accordance with the World Medical Association Declaration of Helsinki. Ethical Committee approval was not deemed necessary.

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