

## Case Report

### Knife in The Head: A Case Report On a Stab Injury of the Petrosal Bone and Literature Review

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#### Abstract

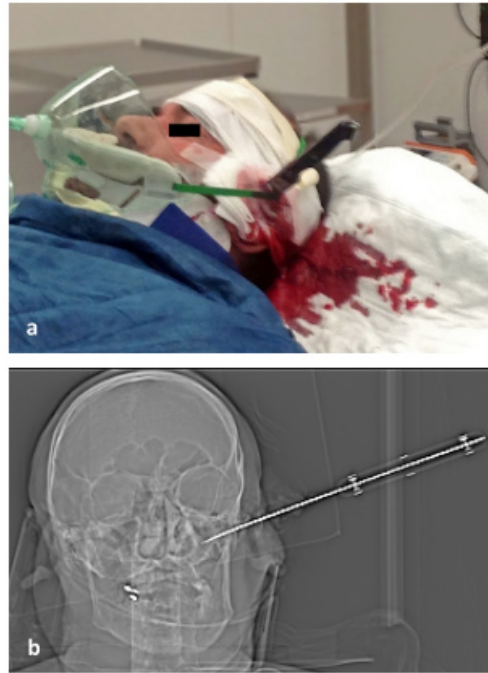
Penetrating traumata of the head are generally life-threatening injuries, whose management poses a substantial challenge for emergency department teams. These injuries are characteristically violence-associated and frequently accompanied by damage of essential organs including brain, meninges, large vessels, cranial nerves, eyes, viscerocranium, internal ear, and/or labyrinth. Here, we present an exceptional case of head trauma caused by a knife blade, which was stuck deep inside in the petrous bone. After the extraction of the knife, the patient suffered from very few immediate and no long-term post-traumatic complications. In conclusion, high-end technical equipment as well as an interdisciplinary team of specialized physicians is recommended for the management of penetrating head trauma to optimize the outcome.

#### Introduction

Penetrating traumata of the head are generally life-threatening injuries, whose management poses a substantial challenge for emergency department teams. These injuries are characteristically violence-associated and frequently accompanied by damage of essential organs including brain, meninges, large vessels, cranial nerves, eyes, viscerocranium, internal ear, and/or labyrinth. Here, we present an exceptional case of head trauma caused by a knife blade, which was stuck deep inside in the petrous bone. After the extraction of the knife, the patient suffered from very few immediate and no long-term post-traumatic complications. In conclusion, high-end technical equipment as well as an interdisciplinary team of specialized physicians is recommended for the management of penetrating head trauma to optimize the outcome.

#### Case Report

Head traumata by thrusting weapons such as knives are characteristically violence-associated [1, 2]. Their severity is determined by a variety of factors such as penetration site, depth of penetration, or type of the penetrating object. Generally, these injuries are life-threatening as they are frequently accompanied by damage of essential organs including brain, meninges, large vessels, cranial nerves, eyes, viscerocranium, internal ear, and/or labyrinth [1-4]. Due to the high risk of vital complications and the relative scarcity of such traumata, their management poses a substantial challenge even for emergency department teams of tertiary care hospitals. Nevertheless, only few case reports are available describing the management of similar traumatic head injuries. Particularly, to the best of our knowledge, there is no publication discussing the case of a knife stuck in the petrosal bone and its management in a tertiary care hospital.



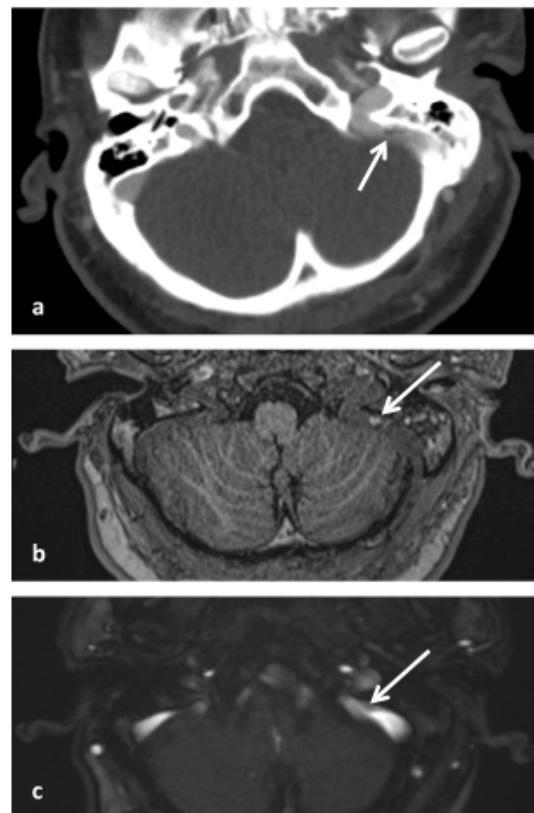
**Figure 1:** Status upon admission to the emergency department. Side view of the patient with the knife in situ (A). Reformatted CT-image illustrating intrusion direction and depth of the penetrating knife in the left petrosal bone region (B).



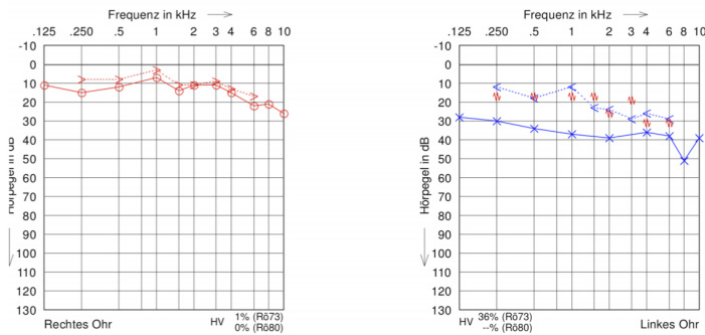
**Figure 2:** Status upon admission to the emergency department. Coronal reformatted CT-image of the left petrosal bone (a, native imaging; bone window) and axial reformatted image (b, venous phase; soft-tissue window) illustrating the penetration of the left petrosal bone by a knife after stab injury. The tip of the knife (arrow) is located within the sigmoid sinus (b, \*). Additional finding: Partial occlusion of the left mastoid cells with hemorrhagic fluid.

Cerebral angiography indicated no acute bleeding of the sinus sigmoideus, while the blood flow around the tip of the knife was reduced. The interdisciplinary team of radiologists, anesthesiologists, neurosurgeons as well as otorhinolaryngologists-head and neck-surgeons discussed possible treatment options including the management of potential complications considering the location of the knife. Finally, it was decided to cautiously remove the knife under CT-scan monitoring with surgical standby in case of complications. During the process of evaluation and decision making, it was particularly emphasized not to lever the knife during removal despite the compact and solid structure of the petrous bone as a perforation of the sigmoid sinus should be avoided strictly. After several removal attempts had failed, two persons together were finally able to remove the knife using a large forceps as cross-guard while pulling smoothly on both sides. Two follow-up CT-scans with angiography, immediately and 30 minutes after intervention, did neither reveal an acute intracerebral bleeding nor a cerebrospinal fluid fistula.

Hemostasis in the superficial wound area was achieved by bipolar electrocoagulation. Subsequently, the 2.5 cm wound was sutured and the patient admitted to the intensive care unit for observation and antibiotic treatment. The following days, CT- and MRI-scans were conducted to check for intracerebral bleeding, ischemia, tissue injury, or thrombosis. The CT-scan revealed a filling defect of the sinus sigmoideus and the MRI validated a post-traumatic partial thrombosis of the sinus sigmoideus (Figure 3). The further postoperative course in the clinic was uneventful. No neurological deficit was detectable in clinical examinations and the wound did not show signs of irritation or infection. As expected, audiometry indicated conductive hearing loss due to a hemotympanum (Figure 4). The patient was discharged to ambulatory care after ten days. The 1-month follow-up examination confirmed a neurological status without pathological findings, the wound healed well, and, after complete resorption of the injury, the patient ended up with nothing more but a scar in the temporal area.



**Figure 3.** Status after removal of the knife. Axial formatted CT-image (venous phase; soft-tissue window) with focal, hypodense filling defect in the left sigmoid sinus: Suspicious for posttraumatic partial sinus thrombosis (a). Supplementary MRI-imaging confirmed partial sinus thrombosis of the left sigmoid sinus with a T1W-hyperintense thrombus (arrow in b, axial fat-saturated T1 weighting) as well as a filling defect in the venous TOF-angiography (arrow in c).



**Figure 4.** Audiogram after removal of the knife. Conductive hearing loss on the left side due to hemotympanum.

## Discussion

Head injuries and particularly brain stab wounds implicate vital complications such as intracranial hemorrhage, injury of essential vessels, local or systemic infection, dramatic neurological deficits, and loss of critical systems including the visual, auditory, vestibular, and olfactory system. The likelihood for different complications and the clinical outcome is determined by a variety of factors such as penetration site, depth of penetration, or type of the penetrating object [1-4]. Accordingly, the management of penetrating head injuries depends on these aspects. Therefore, the first step is airway maintenance and hemodynamic stabilization of the patient [3, 5, 6]. Subsequently, it is mandatory to assess the type of penetrating object, the penetration site, penetration depth, as well as the affected and endangered structures [3, 6, 7]. High-resolution computed tomography is essential to exactly analyze the location of the object for planning the removal as well as to conduct follow-up scans of the head to be able to plan the management in case of complications.

Besides, the preoperative cerebral angiography helps to identify damages of the vascular system. Unavailability of these radiologic imaging methods might result in avoidable secondary brain injury [6-11]. As soon as this information have been collected, the removal of the object should be planned accurately to anticipate potential peri- or postinterventional complications [6]. Extractions of penetrating objects should then be performed carefully with minimal additional damage. Penetrating objects in the petrous bone require special attention. First, the petrous bone is the hardest bone in the body, which implies that penetrating objects are fixed firmly in this bone and demand a great force to extract it [12]. Secondly, the petrous bone incases various essential organs and structures such as the inner ear, the labyrinth, the facial nerve, or the carotid artery. Moreover, several critical structures including brain, brain stem, cranial nerves, and big vessels are located in close proximity to the petrous bone implying the potential hazard of these injuries [4, 11, 13].

The major principle is not to attempt to remove the knife before a careful investigation has been performed and the interdisciplinary team is prepared to remove the instrument with an appropriate plan [5]. Removal of the penetrating object should retrace the original trajectory of the knife. During extraction, care must be taken not to produce any rocking movements which may be transmitted to the tip of the knife [1, 3]. An interdisciplinary approach for management and treatment of penetrating head trauma is recommended by most authors. However, the appropriate methods of extraction are controversially discussed in the literature [1-3, 5, 6, 11, 14, 15]. Options to remove the object are either by simple withdrawal or by a surgical approach such as mastoidectomy. Grobelaar et al. described eleven cases, in which no patient had abnormal bleeding or any other relevant complication related to simple withdrawal [14]. In contrast, Glunčić et al. suggested that a blade should be removed through an interdisciplinary team of otorhinolaryngologists-head and neck-surgeons, maxillofacial surgeons, neurosurgeons by a surgical approach performing mastoidectomy, even if there are no signs of vascular injury. The authors promote this approach since a retained knife blade might temporarily tamponade an incised vessel and, hence, removal could subsequently lead to serious hemorrhage. In this context, surgical exposure of the penetrating object as well as the affected vessel would allow immediate surgical management of complications associated with removal of the object. However, in their case, the knife was also impossible to remove by pulling forces when admitted to the hospital emergency unit [2]. Generally, a surgical approach is mandatory, if the brain is affected [1, 11, 15]. As neither endocranial nor inner or middle ear structures were critically affected in our case and imaging revealed only a minimal intrusion into the sinus sigmoideus, we decided to withdraw the knife carefully. A CT-angiography recorded immediately after the intervention showed no bleeding of the sinus sigmoideus after knife removal. Reviewing the literature on comparable injuries described to date revealed that no general appropriate algorithm has been published for the management of such injuries.

Hence, their management requires an individual approach for each case. This might be highly effective and associated with minimal collateral damage only through multidisciplinary teamwork of neuroradiologists, otorhinolaryngologists-head and neck-surgeons or maxillofacial surgeons, and neurosurgeons. To optimize the outcome, interdisciplinary management in a clinic providing maximal medical care would be ideal for treatment of penetrating injuries of the petrous bone. Finally, cautious postoperative care reduces secondary complications such as bleeding or infections. In this context, angiography is essential not only in the acute situation to exclude bleeding complications of arteries or the sigmoid sinus, but also secondary for detection of posttraumatic thrombosis of the sigmoid sinus, a dural arteriovenous fistula, or traumatic aneurysms which may appear months to years after the trauma.

## Conclusions

Despite being rare events, penetrating head injuries are severe threats to the patient's health, which require high-end technical equipment as well as an interdisciplinary team of specialized physicians to be able to provide an optimal treatment. In particular, it is mandatory to meticulously plan the management of such traumata to avoid unnecessary complications by the injury itself as well as by removal of the object.

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## Conflict of Interest Statement

The authors declare that they have no other funding, financial relationships, or conflicts of interest to disclose.

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