

Surgical Management and Prophylactic Antibiotic Treatment of Pneumatic Nailer Penetrating Brain Injury: a Case Report and Literature Review

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Abstract:

Penetrating traumatic brain injury (pTBI) can lead to high mortality and life-threatening complications. The thorough examination and proper treatment are required. A 30-year-old man suffered from the pTBI during work, and the non-contrast computed tomography (CT) scan was revealed the metallic rod penetrated the right temporal skull and extended into the right inferior temporal gyrus, accompanied by subarachnoid hemorrhage. After diagnosis, a right frontotemporal craniotomy with intracranial nail extraction was performed, and prophylactic antibiotics were prescribed. The patient's symptoms resolved, and he was discharged without focal neurological deficits.

Key words: penetrating traumatic brain injury; craniotomy; prophylactic antibiotics

Introduction

pTBI is associated with a high mortality rate and poor prognosis. pTBI induced by objects such as needles, iron rods, wood pieces, and nails is uncommon. Since the introduction of pneumatic nailers in construction in 1959, several cases of intracranial injuries caused by nails have been reported. Most cases of pneumatic-nailer-induced pTBI are due to work-related incidents, but some occur as a result of suicide attempts. Surgical management may be considered due to brain parenchyma injury. This report presents a case of pneumatic-nailer-induced pTBI and the subsequent surgical management and prophylactic antibiotic treatment.

A 30-year-old man was referred to our emergency room (ER) after a nail from a pneumatic nailer penetrated his skull when working as an interior decorator. The incident occurred when he fell and accidentally fired into his right temple. He had no recent history of head injuries or systemic illnesses. In the ER, the patient's chief complaint was cephalalgia and mild vertigo. However, he demonstrated no focal neurological deficit. His Glasgow Coma Scale score was 15, and his modified Rankin Scale (mRS) score was 0. A depression was visible in his right temporal region, with mild local inflammation (Figure. 1A).



Figure 1A: A metallic nail was inserted into the right side of the face (arrow).

A non-contrast CT scan was promptly obtained, which revealed a metallic rod with diameter of 2mm and length of 55.3mm positioned above the zygomatic process of the temporal bone; the rod penetrated the right

temporal skull and extended into the right inferior temporal gyrus. The imaging also demonstrated a subarachnoid hemorrhage involving the right temporal lobe and Sylvian fissure (Figure. 1B-1D).

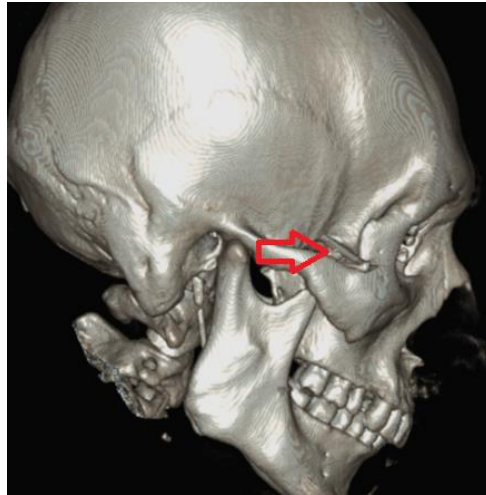


Figure 1B: A metallic rod was positioned above the zygomatic process of the temporal bone (arrow).



Figure 1C: The metallic rod had penetrated the right temporal lobe (arrow).

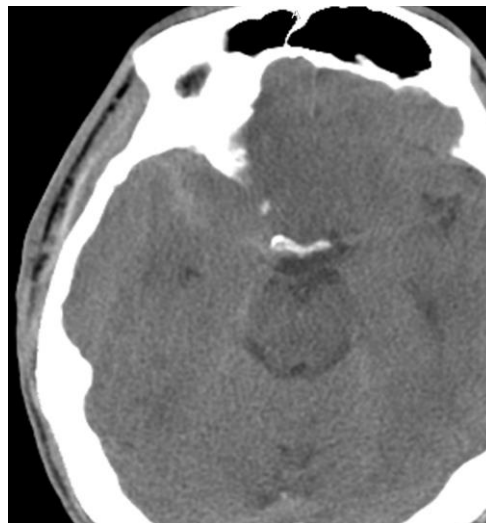


Figure 1D: The non-contrast CT scan revealed subarachnoid hemorrhage involving the right temporal lobe and Sylvian fissure.

After the surgical intervention was explained to the patient, a right frontotemporal craniotomy with intracranial nail extraction was scheduled. Under general anesthesia, the patient was positioned supine on the operating table with the head slightly tilted to the left. The operative field was meticulously prepared, sterilized, and draped using a standard

aseptic technique. A curvilinear incision was made over the right frontotemporal region, posterior to the hairline and inferior to the zygomatic arch, providing direct access to the puncture site of the nail (Figure. 2A).



Figure 2A: A curvilinear incision was made over the right frontotemporal region (red dotted line).

The incision was deepened, and the galea aponeurotica was meticulously dissected from the underlying muscle layer, with caution exercised to avoid injury to the superficial temporal artery. A craniotomy measuring

approximately 5 × 3 cm was performed on the right temporal bone, positioned superior to the nail (Figure. 2B).

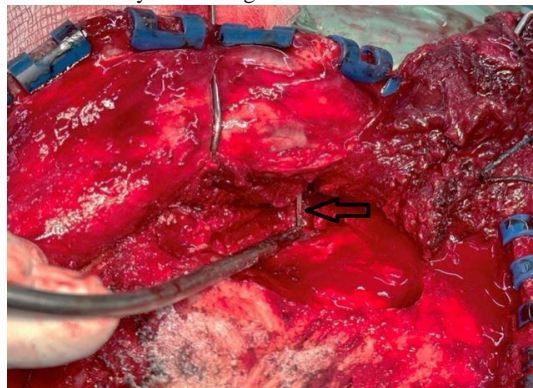


Figure 2B: The metallic nail was exposed during the craniotomy (arrow).

A dura tenting suture was placed initially to control active bleeding and prevent the formation of a secondary epidural hematoma. Profuse bleeding was noted around the nail, necessitating a pin cutter to sever the nail after the dura was carefully opened. Upon removal of the intracranial portion of the nail, oozing from multiple small vessels along the nail tract was observed. Bipolar coagulation and Surgicel, an absorbable

hemostatic agent made from oxidized regenerated cellulose, were employed to achieve hemostasis. The remaining nail portion was then extracted from the skin, and the nail track was irrigated with a vancomycin solution. The bone flap was subsequently replaced and secured using mini plates. The extracted nail measured approximately 2 mm in diameter and 50 mm in length (Figure. 2C).



Figure 2C: A metallic nail, approximately 2 mm in diameter and 50 mm in length, was removed.

The patient was administered 500 mg of oxacillin via intravenous drip every 4 hours as part of a prophylactic antibiotic regimen, along with a prophylactic anticonvulsant. The patient's symptoms were resolved postoperatively, and no focal neurological deficits were noted. The patient was discharged with an mRS score of 0 and demonstrated no signs of infection, seizure activity, or other neurologic deficits during the 3-month outpatient clinic follow-up.

Discussion

Cases of pTBI engendered by pneumatic nailer incidents are rare, with the majority of cases occurring as a result of occupational accidents. When pTBI involves major vascular injury, it can lead to life-threatening complications. However, most cases require surgical intervention to remove the foreign object. Delaying the removal of intracranial foreign objects can result in complications such as central nervous system (CNS) infection, local inflammatory responses, and foreign-body displacement, potentially leading to further vascular and neural tissue damage.

Currently, guidelines for prophylactic antibiotic treatment following pTBI are not available. However, in cases where a CNS infection caused by methicillin-sensitive *Staphylococcus aureus* is suspected, nafcillin and oxacillin are the recommended antibiotics.

In our case, owing to the presence of subarachnoid hemorrhage at the penetration site, emergent surgical removal of the metallic nail was performed, and hemostasis was achieved. The penetration track was irrigated with vancomycin solution, and intravenous oxacillin was administered to prevent CNS infection.

Skull X-ray scans are effective for screening penetrating materials and detecting skull fractures; however, they have a high false-negative rate when the penetrating materials are radiolucent, such as glass, plastic, or wood.

Thus, the gold standard for diagnosis is non-contrast CT, which accurately identifies the location and characteristics of the foreign object, the trajectory of penetration, and the presence of intracranial hemorrhage and skull fractures.

Additionally, 3-dimensional CT imaging is invaluable for the detailed assessment of bony structures and assisting in preoperative planning.

In our case, non-contrast CT scan was performed to diagnose the metallic nail penetration and associated intracranial hemorrhage, followed by 3-dimensional CT imaging for preoperative planning.

For safety considerations, removing the penetrating foreign body under direct visualization is crucial to prevent complications such as subdural hematoma and intraparenchymal hemorrhage. Preoperative angiography should also be considered for a thorough evaluation, especially if vascular structures are damaged. In some cases, preoperative therapeutic embolization may be warranted. We performed a craniotomy around the foreign body and removed the metallic nail under visualization, followed by appropriate hemostasis. The literature includes a few reports of single metallic nail being removed through gentle traction under local anesthesia, and this is because intracranial hemorrhage is uncommon in such cases. However, our patient's preoperative CT scan revealed subarachnoid hemorrhage, necessitating craniotomy under general anesthesia to control bleeding.

Careful evaluation of the patient's psychological status is crucial in postoperative treatment, as some cases may be associated with mental health issues. Psychiatric intervention may be necessary to address any underlying psychological disorders and to prevent the recurrence of such incidents. According to the patient's father, the injury occurred while the

patient was engaged in a home renovation project. Notably, the patient had no prior history of psychological disorders. Three months postoperatively, the patient fully returned to his daily work without any neurological deficits or psychological complications.

Conclusion

Immediate management of pneumatic-nailer-induced brain injury is crucial, with a preference for metallic nail removal under direct visualization through craniotomy, particularly in patients presenting with preoperative hemorrhage. Although no formal guidelines exist for pTBI, prophylactic antibiotics are recommended to prevent potential infection.

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