Article published online: 2023-07-13

When a Transorbital Penetrating Brain Injury Reveals the Infratentorial Tumor: A Case Report and Technical Note

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Indian J Neurotrauma

Abstract

A 62-year-old man was referred for a transorbital injury. A preoperative computed tomography scanner confirmed an 8 cm long × 14 mm wooden piece penetrating the right orbit and perforating the anterior cranial base until the frontal lobe with no apparent prominent vascular injury. However, an unexpected posterior fossa tumor causing blocked hydrocephalus was unveiled. Extraction of the wooden stick was safely achieved after intracranial exploration followed by meticulous cleaning and careful watertight closure to prevent cerebrospinal fluid (CSF) leakage. Except the right eyesight loss, he initially recovered well, were it not for his hard-to-treat hydrocephalus. What at the time of its discovery seemed to be a less important but very likely the indirect cause of its injury, became unexpectedly problematic. Despite all CSF diversion procedures, the patient worsened gradually. Neither a failed attempt to remove the tumor due to the fourth ventricle floor broad infiltration nor the posterior fossa decompressive craniectomy succeeded in improving his neurological status. Despite the diagnosis of a grade II ependymoma, the tumor demonstrated an aggressive radiological behavior with an intense edema of the brainstem, possibly the cause of his drowsiness. Unfortunately, he died of tumor progression solely 52 days after his transorbital injury.

Keywords

- traumatic brain injury
- penetrating brain injury
- hydrocephalus
- posterior fossa
- ependymoma

Introduction

Traumatic brain injury (TBI) is a public health concern and one of the leading causes of death and disability, with an estimated incidence of 64 to 74 million persons per year.[1] About 5.5 million people are estimated to suffer from severe TBI (STBI) each year (73 cases per 100,000 people), especially in least developed countries.[2] Penetrating brain injury (PBI) is relatively less common but the most lethal form with mortality rates as high as 90%, the main cause being gunshots.[3] Of these PBI, transorbital PBI (TOPBI) cases have been even more infrequently described.[4]

Case Report

A 62-year-old man without significant past medical history except a mixed anxiety–depressive disorder was referred in emergency for a TOPBI. He was found comatose at home by his wife with a branch breaking through his right orbit (►**Fig. 1A**). The computed tomography (CT) scan confirmed an 8 cm long × 14 mm in diameter wooden piece penetrating the orbit and perforating the anterior cranial base (►**Fig. 1B–F**). The CT angiography did not show any suspicious vascular injury but an unexpected tumor in the posterior fossa (►**Fig. 3A**).

DOI https://doi.org/10.1055/s-0043-1769801.
ISSN 0973-0508.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

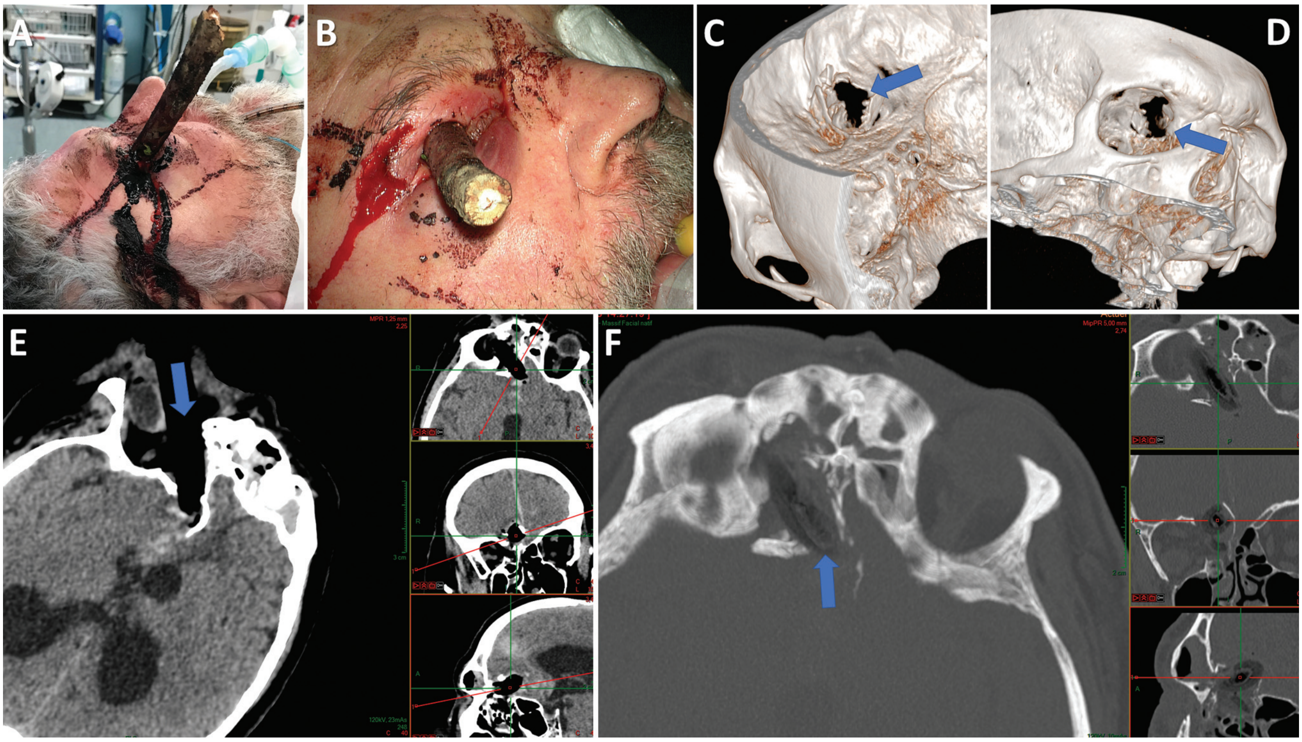

Fig. 1 Preoperative images. (**A, B**) Photographs showing the piece of branch penetrating the right orbit medially and above the right eyeball. (**C, D**) Three-dimensional reconstruction (volume rendering) in bony windows of the skull base showing the fracture (*blue arrow*). (**E**) Three-dimensional views in parenchymal window of the penetrating branch materialized by the *blue arrow*. (**F**) Three-dimensional views in bony window of the penetrating branch materialized by the *blue arrow*.

Technical Note

Extraction of the branch followed by a watertight closure of the skull base fracture via a bicoronal incision was planned. Head pined in a Mayfield skull clamp (►**Fig. 2A**), the frontal scalp was released and retracted downward until to expose the supra orbital ridge. A basal frontal parasagittal bone flap was cut (►**Fig. 2B**). Along with 100 mL of mannitol infusion, the frontal horn of the right ventricle was punctured with an

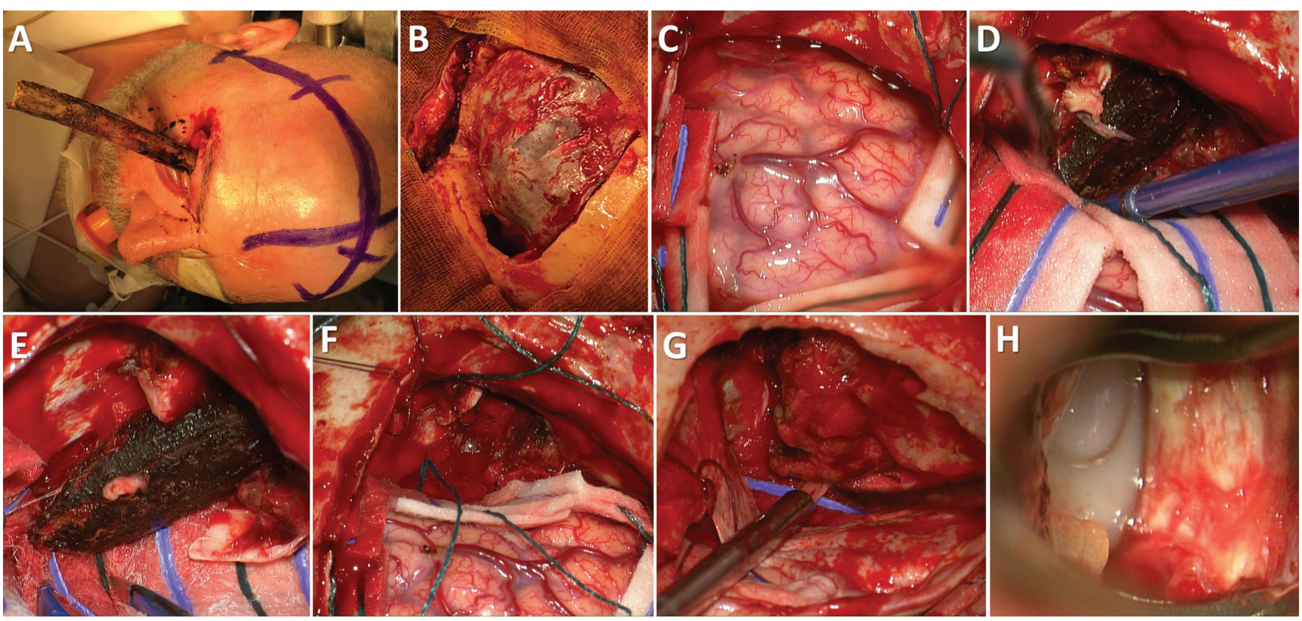

Fig. 2 . Surgical images. (**A**) Head pined in a Mayfield skull clamp showing the mark of the bicoronal incision. (**B**) Dura mater exposition after basal frontal parasagittal bone flap cut with right frontal sinus opening. (**C**) Exposition of the right frontal lobe after dura mater opening. (**D**) Upward retraction of right lobe to expose the branch. (**E**) The tip was exposed and after exploration, its surroundings were protected with neurosurgical patties. (**F**) After having pulled out the branch, the intradural field is washed out and explored. (**G**) The extradural part displaying the superior contents of the orbit via the fractured orbital roof was also explored and cleaned. (**H**) Reverse exploration through the upper eyelid wound and transorbital path confirmed the watertight skull base closure.

external ventricular drain (EVD) to remove 50 mL of cerebrospinal fluid (CSF) to decrease the intracranial hypertension. After dura mater opening, the frontal lobe was gently retracted to progressively expose the piece of wood (►**Fig. 2D**). After exposure to ensure that no critical structure was harmed, the branch surroundings were protected with patties (►**Fig. 2E**). Then, with significant traction, it was pulled out. Further intra (►**Fig. 2E**) or extradural exploration (►**Fig. 2F**) retrieved numerous wood debris mixed with bone fragments, and a contused frontal lobe. A careful washout of the craniocerebral wound was achieved and then, a multilayered sandwich of galea and epicranium was glued (Tisseel Baxter) on the dura mater. The right opened frontal sinus was cranialized before the bone flap was put back in place followed by a standard closure. A reverse exploration after further washing of the transorbital path through the upper eyelid wound confirmed the watertight skull base closure (►**Fig. 2H**).

Initial Outcome

Thirty-six hours thereafter, the patient was awake but confused (Glasgow Coma Scale score 14). Magnetic resonance imaging (MRI) confirmed the occurrence of a fourth ventricle tumor with an important brainstem edema (►**Fig. 3B,C**). Recollection of previous week's history teaches us that he started to suffer from worsening imbalance, unsteadiness, urinary incontinence, and neurocognitive disorders. He even already had, after acute alcohol consumption and falling on the street ground, an STBI 8 weeks ago. At that time, the CT scan demonstrated a bilateral petrous bone fracture, mild diffuse traumatic intracranial bleeding, and hemorrhage of the cerebellar vermis compressing the fourth ventricle. As the surveillance scan at 8 days showed a stable ventricular dilatation, he was sent back home with further exploration prescription.

Even if the patient recovered quite quickly from his TOPBI, it was not possible to wean the EVD. An endoscopic third ventriculostomy (ETV) was therefore performed followed by several lumbar punctures demonstrating an elevated proteinorachy (3.4 g/L) (►**Fig. 3F,G**). His right eyesight did not recover but his neurological status improved greatly, and he was transferred to rehabilitation 22 days after his admission.

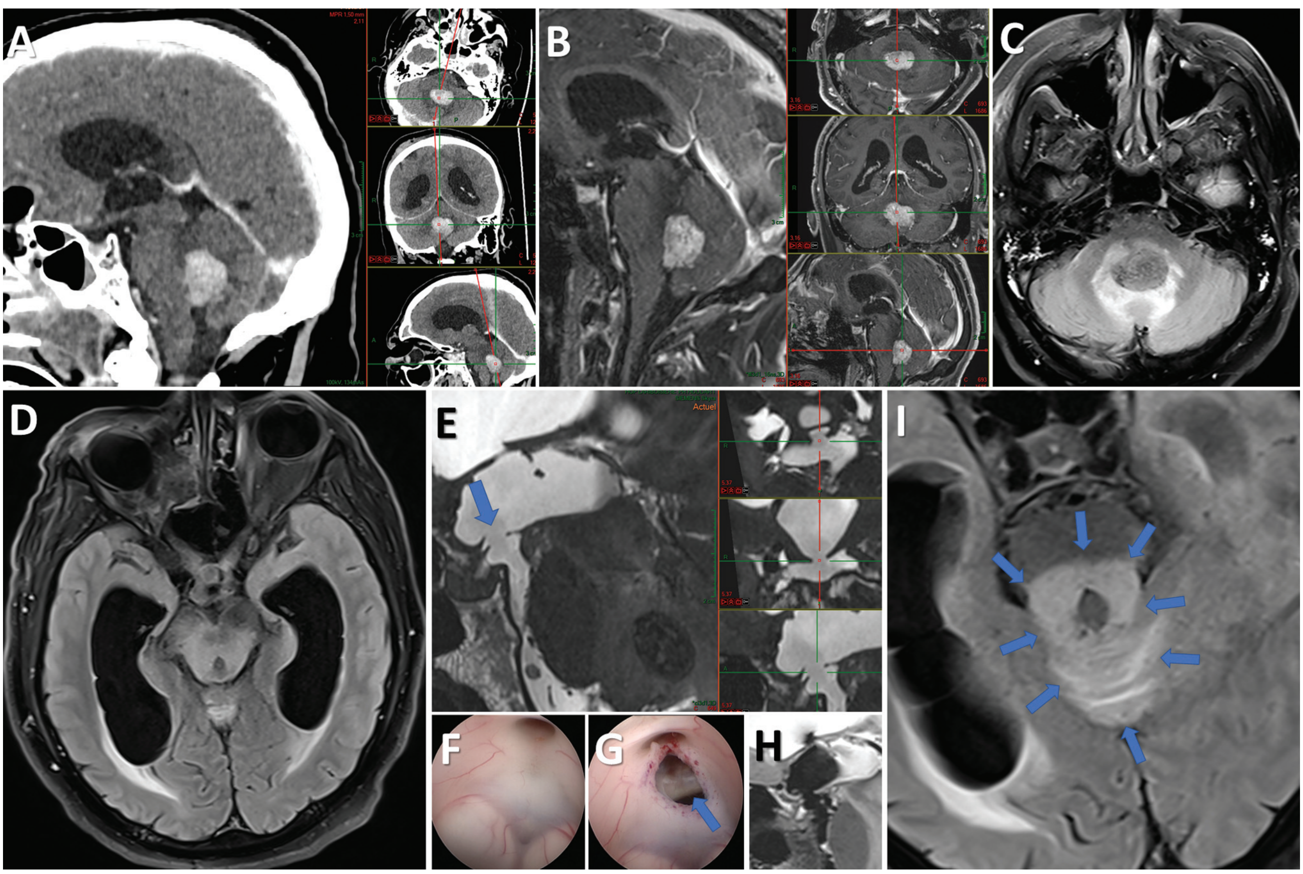

Fig. 3 (**A**) Three-dimensional (3D) iodine-contrasted computed tomography scan images showing the posterior fossa tumor and related hydrocephalus. (**B**) 3D enhanced magnetic resonance imaging (MRI) T1 magnetization prepared – rapid gradient echo (MPRAGE) fat-saturation (FS) images depicting the posterior fossa tumor and related hydrocephalus. (**C**) Axial T2 FLAIR MRI showing the parenchymal and brainstem edema surrounding the tumor. (**D**) Axial T2 fluid-attenuated inversion recovery (FLAIR) MRI depicting the recurrent hydrocephalus at readmission. (**E**) Sagittal T2 constructive interference in steady state (CISS) 3D showing the third ventricle floor stomy (*blue arrow*). (**F**) Endoscopic operative view of the floor of the third ventricle before its puncture. (**G**) Endoscopic operative view of the stomy; the clivus is clearly visible witnessing the opening of the Liliequist membrane (*blue arrow*). (**H**) Sagittal 3D T2 volume showing the black MRI signal artifact of the cerebrospinal fluid flow across the stomy. (**I**) Axial T2 FLAIR MRI depicting the mesencephalon edema encompassing the reticular formation (*blue arrows*).

Final Outcome

Unfortunately, he came back solely 6 days thereafter because of increasing drowsiness. A redo MRI showed an important triventricular dilatation despite a well-functioning third ventriculostomy associated with a more visible brainstem edema (►**Fig. 3E,H,I**). An urgent ventriculoperitoneal shunt insertion improved somewhat his state but, again, 6 days later, he was gradually becoming unresponsive. He remained comatose despite the shunt revision that proved to be fully functional. His family related that the patient had clearly expressed his wish of not living disabled and that he was upset by the recent decline in his condition.

An open surgical biopsy ± resection of the tumor with a posterior fossa decompressive craniectomy was still performed to ensure the diagnosis. The preoperative impression confirmed the MRI suspicion, that is, an extended and deep tumoral infiltration of the fourth ventricle floor preventing a safe and easy resection. Histopathological diagnosis confirmed a grade II ependymoma. Despite all the interventions, the patient remained comatose until his death solely 52 days after his TOPBI.

Discussion

Depending on their localization, intracranial tumors produce a variety of symptoms such as dizziness or motor weakness, which may cause, for example, the patient to fall. Falling from own height is common beyond a certain age, rarely associated with severe TBI, often regarded as unspecific and thus usually neglected. In present very unfortunate case, it was impossible to disregard the TBI, likely the consequence of his hydrocephalus. TOPBI secondary to nonprojectile is a rare incident.[5,6] The orbit is a horizontal pyramid-shaped structure with thin bony walls vulnerable to breach. The frequent path of penetration is via the roof due to the fragility of the superior orbital plate, often resulting in frontal lobe damage, as in our case. Intracranial complications include, for example, cerebral contusion and hemorrhage, CSF fistulas, and later, infection. Management of patients with TOPBI should follow basic principles, including removal of the object under direct vision after in situ exploration, thorough debridement, careful washout, and meticulous dural closure. Early surgical treatment is likely to be successful, and most TOPBI have usually a good outcome except for the involved eyesight.[7] If it were not for his posterior fossa tumor, our patient would have had a favorable prognosis.

Ependymomas are rare central nervous system tumors arising from ependymal cells of the ventricular lining of the brain and central canal of the spinal cord. In adult, they constitute 3 to 5% of gliomas, and infratentorial ependymomas are less common compared to supratentotrial and spinal cord tumors.[8] In Guyotat et al's study, which reported on adult infratentorial ependymomas, 27.4% required hydrocephalus treatment but no more precision is given regarding the method used.[9] As per the result by Marx et al, who found a frequency of hydrocephalus prior to posterior fossa tumor surgery in adult patients of 21.4%,[10] ETV is a reliable method to treat posterior fossa-related hydrocephalus with low rates of complications and failures, that is, patients needed permanent internal CSF diversion.[11,12] However, the ETV failed to bring in our patient a lasting ventricle volume reduction despite its proven permeability (►**Fig. 3E,H**).[13] The patient had indeed a mixed hydrocephalus, and a CSF resorption impairment may be due to an elevated level of CSF protein. Moreover, in present case, further CSF shunt failed to improve durably his neurological state. It was hypothesized that the tumoral infiltration of the fourth ventricle floor, and subsequent brainstem edema, was predominantly responsible for the patient's minimally conscious state. A surgical resection of the tumor was not immediately planned due to the septic situation, the need to recover from STBI, and according to the patient wishes. Nonetheless, as the patient's condition gradually worsened, it was decided as a last resort to get at least a sample of the tumor to assert the diagnosis and guide the outcome. Unfortunately, as expected by MRI review, the tumor broadly infiltrated the fourth ventricle floor, rendering a straightforward gross total resection without postoperative complication very unlikely. Previous studies have identified that factors such as high grade, location, or age older than 45 years correlated with ependymoma patients' reduced survival.[14,15] Grade II is the most commonly encountered subtype ependymoma. Complete surgical resection conferred increased progression-free and overall survival.[8] As this was not achievable in our patient's case without high risk of postoperative disabilities due to the tumoral infiltration, no further tumor debulking was attempted after the biopsy. The posterior fossa decompressive craniectomy failed to improve his neurological status. According to the patient's wishes relayed by his family speech, of not living disabled, unable to take care of himself, no further resuscitation was provided.

Conclusion

This unusual neurosurgical version of the idiom "not see the wood for the trees" illustrates how an impressive craniocerebral injury, finally not so difficult to treat with a potentially good outcome, violently unmasked a more complex neurosurgical problem, which was found to be unsolvable and ultimately led this very unfortunate patient to his death.

Statement of Ethics

This case report complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. Ethical approval was not required for this case report in accordance with the French Scientific Research Ethics Committee policies. Informed consent for publication of this case report and any accompanied images was obtained from the patient's next of kin (son).

Data Availability

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Funding

None.

Conflict of Interest

None declared.

Acknowledgments

We would like to thank Mrs. Segolène Van Outheusden, London, England, United Kingdom, for manuscript review, English proofreading, grammar, and spelling check.

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