CASE REPORT ARTICLE

Transient Survival After a Self-Inflicted Trans-Temporal Gunshot Traversing the Midbrain and Diencephalon: A Case Report

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Abstract

Background Self-inflicted gunshot wounds to the head are uncommon in adolescents and are almost always fatal because of the high kinetic energy and destruction of vital brain structures.

Case Presentation We report a 17-year-old male who sustained a self-inflicted trans-temporal gunshot wound. Computed tomography revealed a right-to-left bullet trajectory traversing the midbrain and diencephalon with extensive bilateral temporal destruction. Despite immediate resuscitation, mechanical ventilation, and osmotic therapy, the patient remained comatose (GCS 5T) and developed progressive brainstem dysfunction. He survived for 15 hours after injury before cardiac arrest occurred.

Conclusion Survival after a sharp gunshot that crosses the mesencephalon–diencephalon junction is particularly rare. This case determines that transient survival can occur when the bullet follows an oblique trajectory that spares key autonomic centers, while secondary injury mechanisms cause delayed worsening .

Keywords Diencephalon, Gunshot wounds, Midbrain, Suicide, Traumatic brain injury

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1 Introduction

Self-inflicted firearm injuries are a major cause of traumatic death globally, mainly affecting adolescents and young adults. Data from the World Health Organization indicate that suicide is the fourth leading cause of death among individuals aged 15–29 years, with firearms contributing substantially to these fatalities in regions where guns are readily accessible.[1]
Wounds due to self-infliction gunshots to the head are usually devastating because of the high kinetic energy involved and the widespread damage to cerebral structures.[2] In clinical practice, we observe that more than 90% of these patients do not survive to reach the hospital, and only rare of them arrive alive for evaluation.[3] The severity and outcome of the injury mostly depend on the bullet's trajectory, caliber, and the specific neural structures affected. Particularely, injuries crossing the midbrain, pons, or diencephalon almost prove fatal because they disturb critical components of the reticular activating system, autonomic centers, and other critical neural pathways.[4]
Several factors are associated with principally poor results, including a low Glasgow Coma Scale (GCS) score on admission and trajectories that involve both hemispheres or cross the ventricles. In this report, we are going to consolidate current information on the management of penetrating gunshot injuries to the head, focusing on prognostic indicators and survival results observed in clinical practice.[5] We report a patient who survived for 15 hours, while gunshot trajectory passed through the mesencephalon and diencephalon and exited contralaterally.

2 Case Presentation

A 17-year-old man, with no previous medical history, was brought to the emergency department nearly one hour after sustaining a self-inflicted gunshot wound to the head. According to family members, the patient had a brief emotional conflict with his father. Then a single gunshot was heard at around 3:00 a.m. Upon arrival of emergency medical services, he was found unconscious with a gunshot entry wound over the right temporal region and an exit wound over the left temporal scalp. There was no active bleeding, but the bullet and bone fragments were scattered around the both sites.
The patient was admitted on the trauma center at about 4:00 a.m. and primery GCS score was 5T (E1VtM3) v. Pupils were fixed and dilated bilaterally and vital signs were quite stable: blood pressure 106/70 mmHg, pulse rate 92 beats per minute, and saturation of oxygen 97% on mechanical ventilation with Fio2 of 80%. Brainstem reflexes, including corneal and gag reflexes were intact . Motor response was limited to flextion in the upper extremities and extention in lower extrimitis (decorticate posturing). No significant active bleeding or associated injury was identified in the nose, ears, oropharynx or any other sites.
Primary resuscitative management included endotracheal intubation and intravenous fluid therapy, and administration of mannitol 1gr/kg and hypertonic saline to prevent cerebral edema. Also empirical broad-spectrum antibiotics and anticonvulsants were administered. Despite all these struggles, the patient remained unresponsive.
The patient was admitted to the intensive care unit (ICU). Neurosurgical consultation concluded that surgical intervention would not be quite beneficial to the patient due to the fascinating nature of the injury and the extent of brainstem involvement. Therefore, just conservative measures were continued. Neurological Exam after 6 hours shows GCS was 3T (E1VtM1). Pupils remained fixed and dilated and serial monitoring revealed progressive loss of brainstem reflexes, including corneal and gag reflexes.

Vital Signs (Hourly)

Blood pressure trended upwards to 140/90 mmHg , followed by a gradual decline to 90/60 mmHg after 6 hours. Heart rate decreased from 92 to 132 bpm. Temperature was maintained at 37°C.
The patient demonstrated clinical signs of progressive intracranial hypertension. After 10 hours, he developed new-onset bradycardia (HR 40-45) and hypertension (BP 150/95), consistent with Cushing's triad. Repeat neurological examination confirmed no return of brainstem function.
Second CT imaging was deferred due to hemodynamic instability. Despite greatest medical management with osmotic agents and mechanical ventilation, increased intracranial pressure, conduced to progressive brainstem dysfunction.
Approximately 15 hours after admission, the patient developed bradycardia and hypotension refractory to inotropes. Finally, cardiac arrest ensued, and despite continued cardiopulmonary resuscitation, he was pronounced dead.

Neuroimaging Findings

Non-contrast computed tomography (CT) of the brain showed a right-to-left trans-temporal gunshot trajectory (Figure 1a and Figure 1b). The entry point was at the right temporal bone, traversing the midbrain and diencephalon, with an exit defect in the left temporal region while effacement of basal cisterns and transition of a bullet from one dural compartment to the next and crossing coronal planes. Numerous comminuted fractures

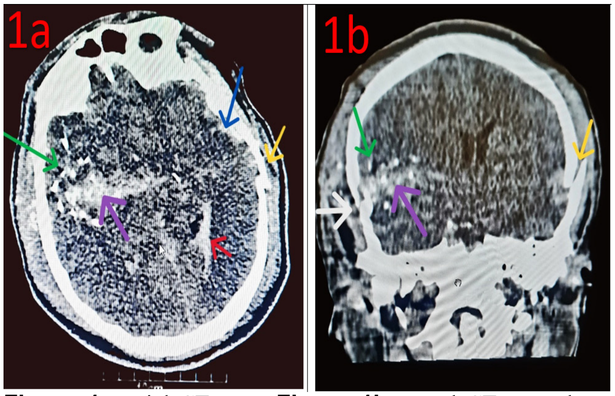

Figure 1a axial CT scan, **Figure 1b** cronal CT scan show green arrow: retained bone; white arrow: entry; yellow arrow: exit; purple arrow: ICH, intracerebral hematoma; red arrow: IVH, intraventricular hematoma; blue arrow: SDH, subdural hematoma

were identified in both temporal bones, and bone pieces were scattered throughout the wound track, as shown in Figure 2. The exit point is usually associated with more devasting defect and more extensive tissue disruption than entry point. Evidence of diffuse cerebral edema , intraparenchymal hemorrhage involving the right and left temporal lobes, and secondary intraventricular hemorrhage were notable.

The CT findings showed a disturbing primary brainstem injury, with widespread involvement of deepgray matter structures. Due to the crossing trajectory through the midbrain and diencephalon, the outcome was deemed extremely poor.

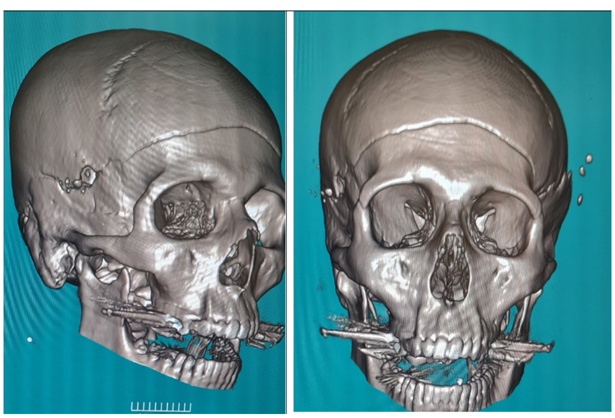

Figure 2 Large exit vs. smaller enrery point

3 Discussion

Self-inflicted gunshot wounds (SIGWs) to the head are among the most devastating forms of traumatic brain injury, particularly in adolescents.[3] Gunshot penetrating head injury has a high mortality rate around 90% in adults and lower in pediatrics, around 65%. The highest mortality rate is between 70–90% before hospitalization and 50% of the survivals die during resuscitation in emergency rooms. Therefore, the management of gunshot penetrating head injury is very challenging for neurosurgeon, especially in pediatrics due to the scarcity of experience and literature.[6]

Although focal neurological deficits are noted in nearly 80% of victims of craniocerebral missile wounds, as the GCS drops, the incidence of focal neurological def¬icit increases precipitously.[7] In one study, the incidence of focal neurological deficit was 100%, 90%, 88%, and 52% with GCS scores of 3–5, 6–8, 9–12, and 13–15, respectively.[8]

Compared with patients with closed head injury, the proportion of patients with gunshot wounds who need intubation, ventilation, and oxygenation at the scene of trauma is much higher.[7] While only 10% to 15% of patients with closed head injury manifest a GCS score of 3–8, this proportion in patients with gunshot wounds to the head jumps to nearly 60%.[9] Our patient also need thracheal intubation and ventilation support in an emergent department.

Evidence overwhelmingly supports the notion that nearly 75% of the 35,000 annual civilian GSWH deaths occur at the scene of trauma, and another 50% of patients admitted to trauma centers die while under the care of neurosurgeons, leaving only 10% of patients suitable for long-term rehabilitation.[9]

Clinically the GCS score can be trusted as a reliable predictor of long-term outcome. Young patients having a GCS score of 6–15 should be monitored closely. The strongest predictor of survival is head CT scan, with the worst finding being a projectile crossing axial, sagittal, and coronal planes and the slug passing from one dural compartment to the next. The next two independent clinical and imaging variables are abnormal pupillary response to light and obliteration of basal cisterns.[10] Abnormal pupillary response, specifically bilaterally fixed and dilated pupils during the patient's treatment course. These patients are 67 times more likely to die as compared to patients with bilaterally reactive pupils, due to their direct tie to brain stem function.[11]

The neurosurgeon has an immense responsibility to select the appropriate patient in terms of prognosis and offer the best surgical intervention. It should be remembered that all penetrat¬ing missile head wounds are open contaminated wounds; patients with violated basal cisterns and ventricular systems have the high¬est chances of CSF fistulas and superinfection. Broad-spectrum antibiotic coverage is needed in patients for 1–5 days (preoperative, intraoperative, and postoperative), and anticonvulsive medications are needed for the first 7 days.[10]

In this case report, the most prominent aspect was how the patient survived immediately after a gunshot wound to the midbrain–diencephalon junction.This is in stark contrast to injuries that cross the central gray-matter or what is termed the "zonal fatalis," a term described by Aarabi et al.[12]

Our patient's trajectory was catastrophic, traversing this critical zone with direct brainstem involvement, which typically results in immediate or rapid mortality. The observed 15-hour survival period, along with the initial neurological findings of a GCS of five and the presence of a gag reflex on primary survey, suggests a possible temporary, partial sparing of specific pontomedullary pathways at the moment of impact. However, this fragile preservation of lower brainstem function was progressively lost over the subsequent hours due to refractory cerebral edema, hemorrhagic expansion, and ultimately, terminal transtentorial herniation, leading to complete brainstem failure and death.

Here, we postulate that the observed 15-hour survival, despite a trajectory through the brainstem, may be explained by mechanisms identified in prior ballistic literature.[13] The bullet in this case likely followed an oblique, skimming trajectory through the brainstem, navigating between rather than directly destroying the compact autonomic nuclei of the pons and medulla. This path is consistent with studies suggesting that such a course can limit immediate and complete disruption of vital cardiorespiratory centers.[12] Furthermore, the angled path of penetration likely dissipated the bullet's kinetic energy over a longer intracerebral distance, a factor shown to produce smaller temporary cavitation and reduce acute neuronal shearing—mechanisms that can theoretically delay the onset of complete brainstem failure.[12] Thus, the initial preservation of minimal brainstem function, evidenced by the early gag reflex and transient hemodynamic stability, may be attributable to these mitigating anatomical and ballistic factors, before succumbing to delayed edema and irreversible herniation. Finally, early survival for 15 hours is biologically reasonable when an angled trajectory (1) avoids immediate damage of compact autonomic centers, (2) limits instant defect/fragmentation, and (3) causes hemorrhage/edema that evolves over time rather than catastrophically at once.[14] In such cases, the patient's Over time, secondary injury mechanisms such as bleeding, swelling, and ischemia progressively impaired vital function; thus, the 15-hour survival window likely represents the latency period before catastrophic secondary failure.

4 Conclusion

Although rare, but transient survival after a disturbing gunshot wound traversing the midbrain and diencephalon is possible.This case proves that an oblique bullet trajectory may initially spare critical autonomic centers, allowing for short-term survival. However, the subsequent unavoidable progression of secondary injuries, such as edema and hemorrhage, leads to delayed neurological fatality. This demonstrates that the initial anatomical pathway of the projectile is a vital determinant of early survival in otherwise nonsurvivable brain injuries.

Declarations

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Artificial Intelligence Disclosure
Artificial intelligence (ChatGPT) was employed only to improve the clarity and language of the manuscript, not to generate any content. The authors are solely responsible for the text and findings.

Authors' Contributions
Peyman Gholipour contributed to the achievement of clinical data and imaging. Arefeh Khan-Oghlan was responsible for writing, editing, and finalizing the manuscript. Both authors reviewed and approved the final version of the manuscript.

Availability of Data and Materials
All clinical and radiological data supporting this case report are available from the corresponding author upon reasonable request.

Conflict of Interest
The authors declare that they have no conflicts of interest.

Consent for Publication
Written informed consent for publication of this case and its accompanying images was obtained from the patient's legal guardian and no identifiable patient information, name, or photograph has been included in this report.

Ethical Considerations
This case report was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. All patient identifiers have been removed to ensure anonymity.

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