International Islamic Medical Journal
Journal Homepage ://journal2.unusa.ac.id/index.php/IIMJ

Fatal Transnasal Intracranial Penetration by an Air-Rifle Projectile: A Forensic Case Report

Satria Perwira[1*], Zumirda[2], Syahrul Gani

[1]Department of Forensic and Legal Medicine, Faculty of Medicine, Universitas Almuslim, Indonesia
[2]Department of Surgery, Faculty of Medicine, Universitas Almuslim, Indonesia
[3]Department of Radiology, Bhayangkara Hospital Level II Jambi, Indonesia
*Corresponding Author: satria.perwira@polri.go.id
DOI: 10.33086/iimj.v8i1.8629

ARTICLE INFO

Keywords: Gunshot wounds, Penetrating head injuries, Traumatic brain injuries, Autopsy, Forensic Medicine

Submitted: Feb 23rd 2026
Reviewed: May 4th 2026
Accepted: July 29th 2026

ABSTRACT

Introduction: Gunshot wounds (GSWs) to the head often result in death due to severe damage to internal brain structures and subsequent bleeding. Accurately reconstructing the path of the bullet is crucial for medicolegal inquiries, especially when the entry point is unusual. GSWs entering through the nose are rare and pose diagnostic difficulties, as the bullet may pass through the paranasal sinuses and the front base of the skull before impacting critical brain areas. Combining autopsy results with radiological imaging is vital for an objective assessment of the cause of death.
Case: A middle-aged man was discovered dead and underwent a medicolegal autopsy. The external examination revealed a circular gunshot entry wound at the midline of the nose, measuring around 1.0 × 0.8 cm, with a noticeable abrasion collar, but no exit wound was found. The presence of cyanosis in the lips and nail beds, along with fixed livor mortis in the posterior region and generalized rigor mortis, was noted. The internal examination of the skull showed a fracture at the base and considerable intracranial bleeding, mainly in the posterior cerebral area, accompanied by vascular congestion. A metallic projectile approximately 0.5 × 0.9 cm in size was retrieved from the posterior cranial cavity, and radiographic imaging confirmed its location within the skull. The reconstructed path of the bullet extended from the nasal entry point through the anterior cranial base into the posterior intracranial area. The cause of death was established as fatal penetrating cranioencephalic injury caused by an air-rifle projectile.
Discussion: Unusual entry points like the nasal area can make it difficult to analyze the trajectory and conduct medicolegal evaluations. Features such as an abrasion collar, lack of an exit wound, skull base fracture, and a retained projectile supported reconstruction of an anterior-to-posterior intracranial projectile trajectory. Radiological verification improved the accuracy of projectile positioning and reinforced the forensic findings.
Conclusions: This case highlights the significance of a thorough autopsy and radiological analysis in precisely determining the trajectory and identifying the definitive cause of death in unusual cranial gunshot wounds.

Introduction

Gunshot wounds (GSWs) to the head represent one of the most lethal forms of penetrating trauma due to extensive brain tissue destruction, vascular disruption, and secondary hemorrhagic complications (DiMaio, 1999; Saukko & Knight, 2016). Penetrating cranial injuries are associated with high mortality, particularly when the projectile traverses the skull base and damages critical intracranial structures (Maas et al., 2017). In medicolegal practice, accurate reconstruction of wound trajectory, determination of firing range, and identification of retained projectiles are essential for establishing the cause and manner of death (DiMaio, 1999).

Although most cranial GSWs involve the frontal, temporal, or occipital regions, entry through the nasal region is relatively uncommon. The complex anatomy of the nasal cavity, paranasal sinuses, and anterior cranial base may alter projectile direction and complicate forensic interpretation. Careful assessment of wound morphology, associated fractures, and intracranial hemorrhage patterns is therefore required (Saukko & Knight, 2016).

Radiological imaging plays an important complementary role in localizing retained projectiles and supporting trajectory reconstruction. Correlation between autopsy findings and imaging enhances diagnostic accuracy and strengthens medicolegal conclusions (Thali et al., 2003). This report presents a fatal transnasal intracranial penetration by an air-rifle projectile, emphasizing the importance of integrated forensic examination in atypical craniofacial penetrating trauma.

Case

A 42-year-old man from Indonesia was found unresponsive near his residence and was pronounced dead at the scene. According to information available during the medicolegal investigation, the body was discovered outdoors in the vicinity of the victim's home and subsequently referred for forensic autopsy following a formal request from law enforcement. At the time of examination, there were no records of chronic illnesses, past neurological issues, or recent hospitalizations.

External Examination

The body exhibited posterior fixed livor mortis and generalized rigor mortis, indicating a postmortem interval of roughly 6–18 hours. A circular gunshot entry wound approximately 1.0 × 0.8 cm in size was noted in the midline of the nasal area, with an abrasion collar surrounding it. No soot deposition, powder tattooing, muzzle imprint, or thermal effects were identified around the wound margins. No exit wound was detected. There was cyanosis of the lips and nail beds, but no other significant external injuries were found.

Figure 1. External Examination Findings. (A) Peripheral cyanosis involving the nail beds of the fingers, evidenced by bluish discoloration. (B) Open wound at the nasal midline measuring approximately 1.0 × 0.8 cm, with a distinct abrasion collar and no visible exit wound.

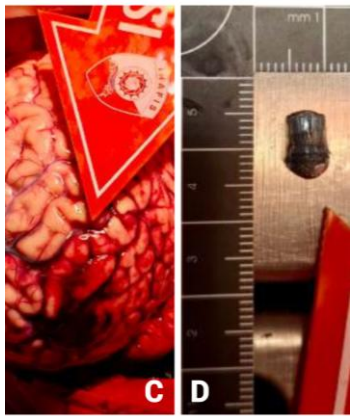

Figure 2. Internal Examination Findings (C) Posterior aspect of the brain demonstrating marked intracranial hemorrhage and vascular congestion. (D) Metallic projectile recovered from the posterior cranial cavity, measured against a metric scale (approximately 0.5 × 0.9 cm).

Internal Examination

Upon examination of the cranial cavity, a fracture of the anterior skull base was discovered. The intracranial examination revealed extensive hemorrhage mainly in the posterior cerebral area, along with vascular congestion. A metallic projectile about 0.5 × 0.9 cm in size was found in the back of the skull. According to information obtained during the medicolegal investigation, the injury was suspected to have been caused by a long-barrel air rifle (pellet gun).

Additional Examination

Skull radiography confirmed the presence and specific location of the retained projectile within the cranial cavity, indicating an anterior-to-posterior trajectory that extended from the nasal entry point through the anterior cranial base into the posterior intracranial compartment.

Since the victim was deceased upon discovery, no medical treatment or intervention was conducted, and no follow-up took place. The autopsy and radiological findings concluded that the cause of death was fatal penetrating cranioencephalic injury caused by an air-rifle projectile.

This autopsy was carried out within the context of a legal medicolegal investigation,

ensuring that all identifying details remained confidential and that ethical standards for forensic reporting were maintained.

Figure 3. Radiological Examination Findings

(E) Anteroposterior view of skull radiography showing a well-defined radiopaque foreign body within the cranial vault (arrow). (F) Lateral view confirming the posterior intracranial localization of the radiopaque foreign body (arrow), consistent with the reconstructed anterior-to-posterior trajector

Discussion

Penetrating cranial GSWs remain a major cause of fatal traumatic brain injury worldwide, with outcome severity strongly influenced by projectile trajectory and intracranial energy transfer (Maas et al., 2017). Recent forensic and radiological studies emphasize that atypical entry points may complicate trajectory reconstruction and require imaging-supported assessment to avoid interpretative error (Sieswerda-Hoogendoorn et al., 2018). Furthermore, contemporary forensic imaging literature highlights the increasing value of postmortem radiology in projectile localization and documentation, particularly in cases involving retained bullets and complex craniofacial pathways (Ampanozi et al., 2020).

While most cranial GSWs involve frontal, temporal, or occipital entry sites, nasal-entry trajectories are relatively uncommon and present unique anatomical and forensic challenges. The nasal cavity and paranasal sinuses form air-filled spaces bordered by thin bony structures that may alter projectile behavior before penetration of the anterior cranial base. This anatomical complexity increases the risk of misinterpretation of wound direction if assessment relies solely on external examination (Saukko & Knight, 2016).

In the present case, the projectile entered through the nasal midline, fractured the anterior skull base, and progressed into the posterior cranial compartment. The absence of an exit wound and recovery of a retained projectile indicate substantial intracranial energy dissipation, consistent with severe traumatic brain injury (DiMaio, 1999). The posterior predominance of hemorrhage corresponded with an anterior-to-posterior trajectory, demonstrating how skull base vulnerability can facilitate direct intracranial extension.

Although air rifles are frequently perceived as low-energy weapons, previous forensic reports have demonstrated that pellet projectiles may produce fatal cranioencephalic injuries when fired at vulnerable anatomical regions, particularly the orbit, temporal region, and other craniofacial structures (Simon et al., 2019; Glowinski et al., 2023; Gilmour et al., 2003). Previous reports have primarily described intracranial penetration through transorbital or temporal pathways. In contrast, the present case involved projectile entry through the nasal midline, resulting in penetration of the anterior skull base and posterior intracranial projectile retention. This trajectory differs from more commonly reported craniofacial pellet injuries and highlights the vulnerability of the nasal cavity as a potential route for fatal intracranial penetration because of the relatively thin anterior skull base.

The cribriform plate and adjacent anterior skull base structures represent some of the thinnest osseous barriers separating the facial skeleton from the intracranial cavity. Consequently, even projectiles with relatively low kinetic energy, such as air-rifle pellets, may achieve intracranial penetration when directed through the nasal cavity. This anatomical vulnerability likely contributed to the fatal outcome observed in the present case and may explain the posterior intracranial trajectory despite the use of a weapon generally regarded as less powerful than conventional firearms.

A key contribution of this case lies in the systematic correlation between autopsy findings and radiological confirmation. In many medicolegal settings, especially in resource-limited environments, trajectory reconstruction may depend solely on gross examination. The use of plain skull radiography in this case strengthened projectile localization and enhanced objectivity in cause-of-death determination. Imaging-supported autopsy increases evidentiary reliability, particularly when atypical entry sites could otherwise lead to diagnostic uncertainty (Thali et al., 2003).

A limitation of the present case is that trajectory reconstruction relied on conventional radiography rather than postmortem computed tomography (PMCT). While radiography successfully confirmed projectile retention and localization, it provides only two-dimensional information. PMCT is increasingly regarded as the preferred modality for forensic ballistic reconstruction because it provides three-dimensional visualization of projectile pathways, fracture morphology, and secondary projectile fragments.

This report therefore underscores not only the rarity of nasal-entry cranial GSWs but also the methodological importance of

integrated forensic assessment in reconstructing complex ballistic pathways.

Precise estimation of firing distance was not possible because classical range-of-fire indicators such as soot deposition, powder tattooing, muzzle imprint, and burning were absent or unavailable for evaluation. Furthermore, the injury was caused by an air-rifle projectile, for which conventional firearm range estimation criteria may not be directly applicable. In addition, toxicological analysis was not available and therefore potential contributions of alcohol or other substances could not be assessed.

To our knowledge, forensic reports describing fatal transnasal intracranial penetration by an air-rifle projectile remain exceedingly rare. This case expands the existing literature by documenting a nasal-entry trajectory with anterior skull base penetration, posterior intracranial projectile retention, and radiographic-autopsy correlation.

Conclusion

This case illustrates that a nasal-entry air-rifle projectile may result in fatal intracranial injury through penetration of the anterior skull base and subsequent traumatic brain injury.

A thorough forensic evaluation, which includes careful examination during the autopsy as well as radiological confirmation, is crucial for accurately determining the path of the projectile and the cause of death. Combining these findings enhances the objectivity of medicolegal investigations, especially in cases with unusual entry points and complex craniofacial structures.

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