

A Silent Conspiracy: A Rare Case of Homicidal Strangulation with Toxicological Confirmation of Paraphenylenediamine Poisoning

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ABSTRACT

Homicidal deaths involving multiple mechanisms of injury present complex challenges for forensic investigation. The present case report describes the medico-legal investigation of a 34-year-old male who died following a combination of ligature strangulation and toxicological poisoning with paraphenylenediamine (PPD). The victim, a resident of southern Punjab, Pakistan, was reportedly involved in a dispute related to financial matters prior to the incident. According to investigative accounts, the individual was assaulted, strangled with a ligature material, and forcibly administered a toxic chemical substance suspected to be PPD. The victim was transported to a tertiary care hospital in critical condition exhibiting neck compression marks, cranial trauma, and signs consistent with toxic ingestion. Despite emergency medical intervention, the patient died approximately forty-eight hours after admission. Medico-legal autopsy revealed distinct ligature marks around the neck, blunt force trauma to the scalp, fracture of the hyoid bone, and chemical burns within the gastrointestinal tract. Toxicological examination of biological samples confirmed the presence of toxic concentrations of paraphenylenediamine in both blood and gastric contents. The findings established traumatic asphyxia due to ligature strangulation as the primary cause of death, with systemic toxicity due to PPD ingestion as a contributory factor. This case highlights the critical role of integrated forensic pathology and toxicology in identifying complex homicidal mechanisms and underscores the importance of multidisciplinary collaboration in medico-legal investigations.

Keywords: Ligature strangulation, paraphenylenediamine poisoning, forensic toxicology, homicide investigation, medico-legal autopsy

INTRODUCTION

Paraphenylenediamine (PPD) is an aromatic amine widely used in permanent hair dye formulations and other cosmetic products (1,3). In several South Asian regions it is commonly referred to as “Kala Pathar” and has been frequently implicated in cases of intentional poisoning due to its accessibility, affordability, and high toxicity (2-5). Ingestion of PPD results in rapid systemic toxicity characterized by severe cervicofacial edema, airway obstruction, rhabdomyolysis, metabolic disturbances, and acute renal failure, often leading to fatal outcomes if immediate medical intervention is not provided (1,2,5,11).

Over the past two decades, numerous reports from South Asia and the Middle East have documented increasing incidences of PPD poisoning in both suicidal and homicidal contexts (1,4,5,9,10). The compound exerts toxic effects primarily through oxidative stress and muscle tissue breakdown, which may lead to life-threatening complications including respiratory distress, renal failure, and cardiac dysfunction (2,3,5,11). Because of these properties, PPD has

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become a significant public health concern in regions where it remains readily accessible in local markets (3,4,9,10).

From a forensic perspective, cases involving poisoning in combination with physical assault present unique investigative challenges (6-8,12). Determining the precise sequence of events and identifying the primary and contributory causes of death require careful integration of autopsy findings, toxicological analysis, clinical records, and investigative information (6-8). In homicide investigations, the coexistence of mechanical injuries and toxicological exposure may indicate deliberate attempts to ensure fatal outcomes or to obscure the true cause of death (6,7,12).

The present case report describes the medico-legal investigation of a fatal incident involving ligature strangulation combined with forced ingestion of paraphenylenediamine. The case illustrates the importance of comprehensive forensic examination and toxicological confirmation in establishing the cause and manner of death in complex homicide cases (6-8,12).

Case Presentation

A 34-year-old male resident of a district in southern Punjab, Pakistan, was reportedly involved in a dispute related to financial matters prior to the incident. According to preliminary investigative reports, the individual was invited to a meeting on 03 March 20** by acquaintances under the pretext of resolving financial concerns. During this encounter, the victim was allegedly subjected to physical assault by multiple individuals.

Witness accounts collected during the investigation indicated that the victim was taken to a nearby workplace facility where he was restrained and assaulted. It was reported that the assailants applied compression to the victim’s neck using a rope-like ligature material and subsequently forced the ingestion of a chemical substance suspected to be toxic. The assault resulted in severe physical trauma and signs consistent with poisoning.

Following the incident, the victim was transported to a tertiary care hospital in southern Punjab in a critically unstable condition. Upon admission, clinical examination revealed pronounced neck compression marks, scalp swelling suggestive of blunt trauma, respiratory distress, and evidence of toxic ingestion. Supportive treatment including airway management, intravenous fluids, and symptomatic care was initiated. Despite intensive medical management, the patient’s condition deteriorated, and he expired approximately forty-eight hours after hospital admission on 05 March 20**.

The case was subsequently referred for medico-legal investigation. Local law enforcement authorities registered the incident under **criminal report number *****/20** and initiated a formal investigation. A medico-legal autopsy was authorized and conducted at the Department of Forensic Medicine of a regional medical institution.

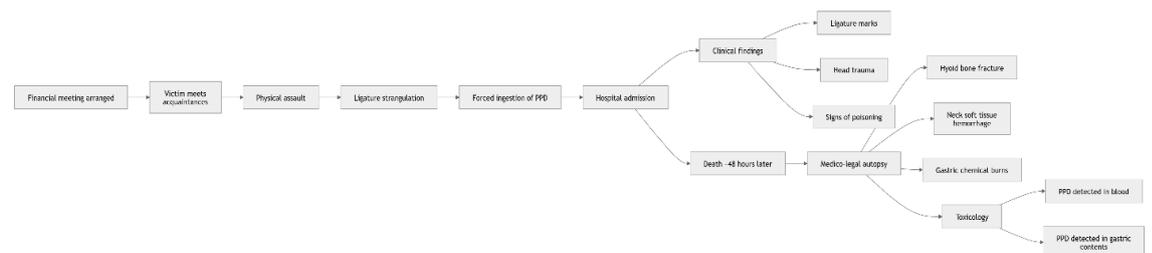


Figure 1 Timeline of Events Leading to Death

Autopsy Findings

External Examination

The body was that of a moderately built adult male estimated to be approximately thirty-four years of age. Postmortem examination revealed the presence of fully developed rigor mortis and lividity distributed over dependent portions of the body.

A distinct ligature mark encircled the anterior and lateral aspects of the neck. The mark measured approximately 2 cm in width and was positioned horizontally below the level of the thyroid cartilage. The margins of the ligature mark were well defined with underlying bruising, consistent with compression of the neck by a ligature material.

Additional injuries included localized swelling and contusions over the scalp, suggestive of blunt force trauma. Abrasions were present within the oral cavity, particularly along the inner surfaces of the lips and buccal mucosa. These findings were considered suggestive of forced administration of a substance during the assault.

No other significant external injuries were observed.

Internal Examination

Cranial Findings

Reflection of the scalp revealed subcapular hemorrhage corresponding to the area of external swelling. The skull bones were intact, and no intracranial hemorrhage was identified. The brain showed mild congestion but no focal lesions.

Neck Structures

Dissection of the neck structures demonstrated hemorrhage within the surrounding soft tissues. A fracture of the hyoid bone was identified, accompanied by localized hemorrhage in adjacent muscles. These findings are commonly associated with ligature strangulation and indicate ante-mortem compression of the neck.

Thoracic Cavity

The ribs and sternum were intact. The lungs were congested with mild edema. No traumatic injury to the thoracic organs was observed.

Gastrointestinal Tract

The stomach mucosa exhibited areas of chemical erosion and burn-like discoloration, particularly along the gastric lining. Similar irritation extended into the proximal segment of the small intestine. These findings were consistent with ingestion of a corrosive or toxic substance.

Liver, Kidneys, and Other Organs

The liver and kidneys appeared grossly normal. Tissue samples from the liver, kidney, stomach contents, and blood were collected for toxicological examination.

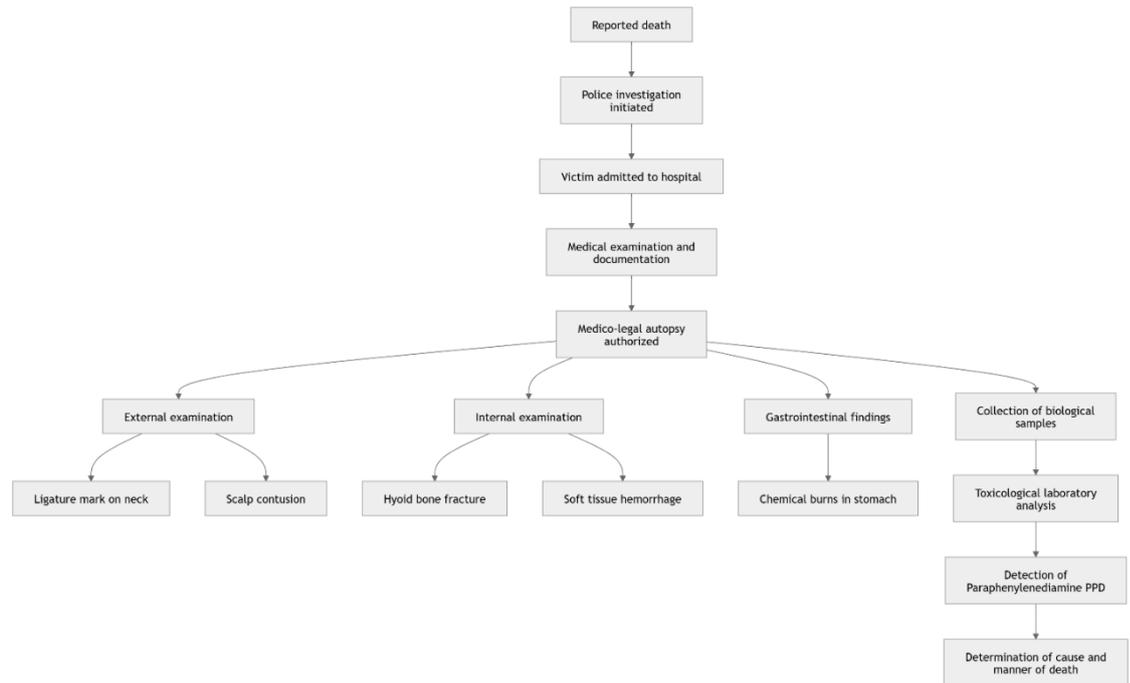


Figure 2 Forensic Investigation Workflow

Toxicological Analysis

Biological samples collected during autopsy were submitted to a provincial forensic toxicology laboratory for chemical analysis. Analytical testing included screening and confirmatory techniques for common toxic substances.

The toxicological examination detected the presence of paraphenylenediamine (PPD) in both blood and gastric contents. The detected concentrations were consistent with toxic exposure. The presence of gastric mucosal damage observed during autopsy corresponded with the chemical properties of PPD ingestion.

These toxicological findings supported the conclusion that the victim had been exposed to a significant quantity of PPD prior to death.

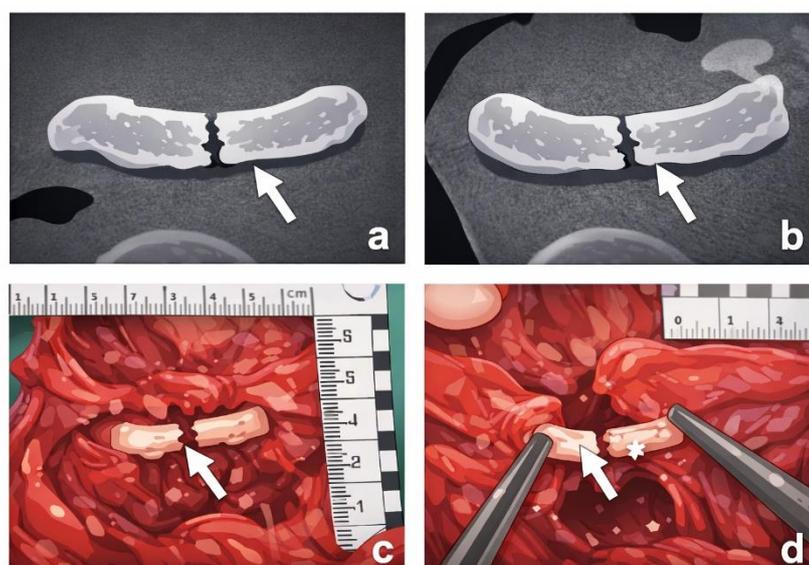


Figure 3 Radiological and autopsy illustration of hyoid bone fracture associated with ligature strangulation. (a) Computed tomography (CT) image demonstrating a fracture line in the hyoid bone (arrow).(b) Reconstructed CT view confirming discontinuity of the hyoid bone

structure (arrow). (c) Schematic illustration of neck dissection showing the fractured hyoid bone during medico-legal autopsy, with measurement scale indicating anatomical orientation (arrow). (d) Close-up schematic depiction of the hyoid fracture site during autopsy examination with surgical instruments highlighting the fracture margins (arrow).

Radiological and anatomical findings demonstrated a fracture of the hyoid bone, which is commonly associated with ligature strangulation and other forms of neck compression. The CT imaging views (Figure Xa–b) reveal a clear disruption in the continuity of the hyoid bone structure, indicated by arrows. These findings were further corroborated during medico-legal autopsy examination.

During neck dissection (Figure Xc–d), the fractured segments of the hyoid bone were directly visualized within the surrounding soft tissue structures. Measurement scales were used to document anatomical positioning and fracture characteristics. The fracture margins and associated tissue hemorrhage were consistent with ante-mortem compression injury to the neck.

These combined radiological and autopsy findings supported the diagnosis of traumatic neck compression resulting in hyoid bone fracture, which is frequently observed in cases of ligature strangulation and homicidal asphyxia.

Cause and Manner of Death

Based on the combined findings of the medico-legal autopsy, toxicological analysis, and investigative information, the cause of death was determined to be:

Primary Cause of Death:

Traumatic asphyxia resulting from ligature strangulation.

Contributory Cause of Death:

Systemic toxicity following ingestion of paraphenylenediamine (PPD).

Manner of Death:

Homicide.

The injuries identified during autopsy were determined to be ante-mortem and collectively sufficient to cause death.

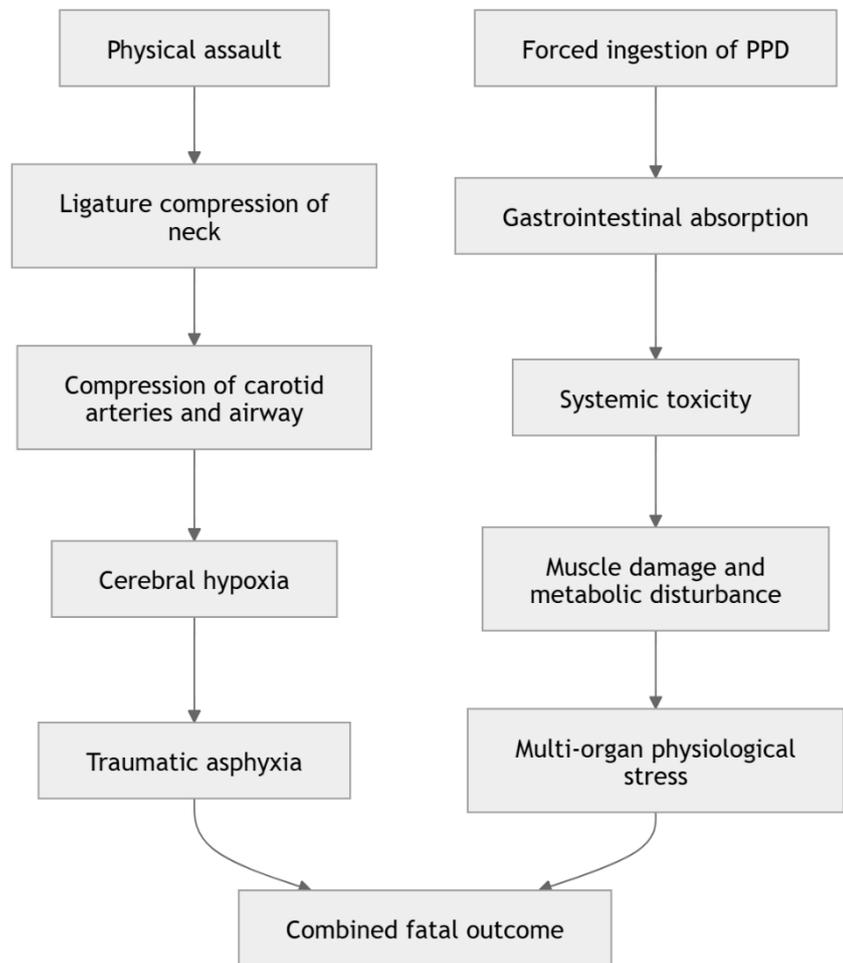


Figure 4 Mechanism of Death Pathway

DISCUSSION

The present case illustrates a rare combination of mechanical asphyxia and toxicological poisoning in a homicidal setting (6-8,12). Ligature strangulation is a well-recognized form of homicidal violence characterized by compression of the neck structures leading to obstruction of blood flow and oxygen supply to the brain (6-8). Typical forensic indicators include ligature marks, soft tissue hemorrhage in neck structures, and fractures of the hyoid bone or thyroid cartilage (6-8,12). In this case, the presence of a horizontal ligature mark and hyoid fracture strongly supported the diagnosis of ligature strangulation (6-8).

The detection of paraphenylenediamine in the blood and gastric contents further indicated the involvement of chemical poisoning (1-5,9-11). PPD is known to cause severe toxic reactions including angioedema, muscle breakdown, and renal failure (2,3,5,11). The chemical burns observed in the gastrointestinal tract provided additional evidence of ingestion of a toxic substance (1,2,5,11).

The coexistence of both strangulation injuries and toxicological exposure suggests that the assailants may have intended to ensure fatality through multiple mechanisms (6-8,12). Such cases present particular challenges in forensic investigation because it is necessary to determine whether the injuries occurred sequentially or simultaneously and to establish the primary mechanism leading to death (6-8).

From a medico-legal standpoint, the integration of autopsy findings with toxicological evidence played a decisive role in establishing the cause and manner of death (6-8,12). The

case also highlights the importance of collaboration among forensic pathologists, toxicologists, clinicians, and investigative authorities when evaluating complex homicide cases (6-8).

Another important aspect of this case is the broader public health concern regarding the accessibility of highly toxic substances such as PPD (3-5,9,10). Despite regulatory measures in some regions, the compound remains readily available and continues to be implicated in poisoning cases (3,4,9,10). Strengthening regulatory control and public awareness may contribute to reducing misuse of such substances (3,4,10).

CONCLUSION

This case report highlights the critical role of forensic pathology and toxicology in determining the cause and manner of death in complex homicide investigations. The combined evidence of ligature strangulation and toxic PPD ingestion confirmed the homicidal nature of the incident. Comprehensive forensic examination, including detailed autopsy and toxicological analysis, remains essential for accurate medico-legal evaluation.

The case underscores the need for continued collaboration between medical professionals, forensic investigators, and law enforcement authorities in order to ensure accurate documentation and justice in medico-legal cases. Furthermore, improved regulation and monitoring of toxic chemical substances may help reduce their misuse in both suicidal and homicidal contexts.

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DECLARATIONS

Ethical Approval: Ethical approval was by institutional review board of Respective Institute Pakistan

Informed Consent: Informed Consent was taken from participants.

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Concept: AA; Design: HUR; Data Collection: MI; Analysis: HF; Drafting: HMAM

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