ISSN-0973-9122 (Print) ● ISSN-0973-9130 (Electronic)

Volume 19 / Number 4 / October-December 2025



Indian Journal of Forensic Medicine & Toxicology

Website: www.ijfmt.com

Official Organ of Indian Association of Medico-Legal Experts (Regd.)

Indian Journal of Forensic Medicine & Toxicology

Editor in Chief
Prof. SK Dhattarwal
Forensic Medicine, PGIMS, Rohtak, Haryana
Associate Editor
Prof (Dr)Jitender Kumar Jakhar
Professor, Forensic Medicine & Toxicology,Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences | PGIMS · Department of Medicine
E-mail: editor.ijfmt@gmail.com

INTERNATIONAL BOARD

- Prof Mete Gulmen, Çukurova Üniversitesi,Tıp Fakültesi Adli Tıp Anabilim Dalı
- Dr. Valery Gunas,Head of department, PhD, docent ,National Pirogov Memorial Medical University, Vinnytsya (VNMU), Ukraine
- Dr. Rahul Pathak Forensic Science, Dept of Life Sciences ,Anglia Ruskin University, Cambridge, UNITED KINGDOM
- Dr Noha A. Magdy Elrafie,Assistant researcher Forensic Toxicology, Ain Shams University, Cairo, Egypt
- Dr Imran Sabri, Assistant Professor, King Faisal University Department of Biomedical Sciences (College of Medicine)Al Hadā, Saudi Arabia
- Emilio Nuzzolese,Professore, Dipartimento di Scienze della Sanità Pubblica e Pediatriche Associate Professor in Legal Medicine at the University of Turin (Italy)
- Dr. Risha Jasmine Nathan Lecturer in Forensic Chemistry Anglia Ruskin University East Road, Cambridge, England, United Kingdom

NATIONAL BOARD

- Prof Sudhir K Gupta,Professor & Head, Department Of Forensic Medicine All India Institute of Medical Sciences, New Delhi
- Dr Shankar Bakkanwar Associate Professor,Department of Forensic Medicine, Kasturba Medical College, Manipal
- Dr Chittaranjan Behera Professor, Department of Forensic Medicine MBBS MD(AIIMS) MAMS FIMSA FICFMT AIIMS ·
- Dr. Asha Srivastava Professor of and Dean , School Behavioural Sciences at the National Forensic Sciences University (NFSU)
- Dr. Raghvendra Kumar Vidua, Professor, Forensic Medicine & Toxicology, AIIMS Bhopal
- Dr. Vaibhav Saran Associate Professor ,Department of Forensic Science, Amity University Punjab
- Dr. Aparna R. Assistant Professor, Forensic Serology & Biology, Jain University, Bengaluru
- Amar Jyoti Patowary,Professor & HOD Forensic Medicine, NEIGRIHMS, Shillong, Meghalaya
- Prof S. Venkata Raghava , Forensic Medicine, Banglore Medical College, Bengaluru
- Dr Shalini Gupta,Professor & Head Histopathology, Cytopathology, Molecular Pathology, Hematopathology, Forensic Odontology King George's Medical University
- Prof.Dayanand G Gannur ,Professor, Forensic Medicine , BLDE Deemed to be University
- Dr. Praveen Arora,Professor & Head, Sri Aurobindo Institute of Medical Sciences · Department of Forensic Medicine
- Prof.Avinash Harishchandra Waghmode Professor & Head Dept of FMT, BKL Walawalkar Rural Medical College Ratnagiri
- Dr. Anita Yadav Assistant Professor Forensic Science,Galgotias University, Greater Noida, UP

Print-ISSN:0973-9122 Electronic - ISSN: 0973-9130

Frequency: Quarterly,

© All Rights reserved The views and opinions expressed are of the authors and not of the Indian Journal of Forensic Medicine & Toxicology. Indian Journal of Forensic Medicine & Toxicology does not guarantee directly or indirectly the quality or efficacy of any products or service featured in the advertisement in the journal, which are purely commercial. It is further mentioned for your information that our journal is a double-blind peer-reviewed indexed international journal. It is covered by Google Scholar, Scilit, CINAHL,EBSCOhost (USA) and many other international databases.

Website: www.ijfmt.com

Published at
Institute of Medico-legal Publications
Logix Office Tower, Unit No. 1704, Logix City Centre Mall, Sector- 32, Noida - 201 301 (Uttar Pradesh)

Indian Journal of Forensic Medicine and Toxicology

Volume 19 No. 4 | October-December 2025

Contents

		Page
1.	**An Interesting Case of Homicide Disguised as an Accident: A Case Report** *Abhishek Sharma, Kirti Parmar, Manoj Kumar Sharma*	**1**
2.	**Concealment of Death in Blunt Thoracoabdominal Trauma** *Abhishek Soni*	**7**
3.	**A Retrospective Analysis of Medicolegal Autopsy Cases Conducted at Gims, Kalaburagi, Karnataka** *Maqdoom Syed Syed Musab, Manish K, Deepak S*	**13**
4.	**Determining the Manner of Fatal Cut Throat Injury and its Challenges: A Case Report** *Gebremariam Tewelemedhin Gebremariam, Charles Karangwa, Innocent Nkurunziza, David Ishimwe*	**19**
5.	**Shades of Blue: A Case Series of Acquired Methemoglobinemia** *Rashmi Ranjan Pattanayak, K Smita Reddy, Biswabikash Mohanty, Pravat Ranjan Sahoo, Amol Parate*	**24**
6.	**Incidental Detection of Foreign Body (bezoar) inside the Stomach in Fatal Poisoning Cases: Reporting of a Series of Cases with Rare and Unusual Autopsy Findings** *Mandal S. Anindya, Abhijeet Bhardwaj, Chandan Bandyopadhyay*	**30**
7.	**Suicide by Charcoal Burning in a Patient on Zolpidem Therapy: A Case Report** *J.S.D. Peiris, Rahimi R.*	**35**
8.	**Forensic Investigations in Cases of Human Rights Violations: Humanitarian and Legal Procedure** *Danijela Bubanja-Petrović, Mirjana Tanić Slavić, Miroslav B. Milošević*	**39**
9.	**Forensic Entomology Cases Documented from Various Regions of India: A Comprehensive Review** *Shazed Fatima, Madhu Bala*	**46**
10.	**A Retrospective Study on Snake Bite Fatalities at a Tertiary Care Hospital in Visakhapatnam (2021 -2023)** *Gummadi Venugopal Rao, Mopuri Venkateswarlu, Srinivasa Rao Vavilapalli, Devaraj Boddepalli, Hari Krishna Chowdary Lingampalli, Mamatha K, Kattamreddy Ananth Rupesh*	**53**
11.	**Evaluation of the Effectiveness of Peer Assisted Learning in Forensic Medicine & Toxicology for Third Phase MBBS Students** *Iram Khan, Mohammad Shakeel, Rinki Kalra, Dilutpal Sharma, R. K. Dixit*	**59**
12.	**A Study on Profile of Death due to Hanging in Jamnagar Region** *Jitendra S. Rathod, Haresh J. Parmar, Chauham A. Desani, Kalpeshkumar R. Chaudhari*	**66**
13.	**A Prospective Autopsy Study of Hanging Deaths Among Individuals Aged 15–60 Years at Tirunelveli Medical College** *Sakthivel K, Arun Balan M, Pary Prasath M, Kaviya K, Arun Kumar M*	**70**

14. **A Retrospective Study on the Impact of Early Hemoperfusion on Survival Outcomes in Acute Paraquat Poisoning** **78**
Kishore R, Varun Byrappa, Arun A Mohanan, Shreyas Satish, Anup Kumar Roy

15. **Assessment of Sexual Dimorphism Using External Ear Morphometry: A Cross-Sectional Study Among Adults in Bardhaman, West Bengal** **83**
Madhavi Phulambrikar (Keole)

16. **A Demographic and Forensic Analysis of Thermal Burn Fatalities: An Autopsy-Based Study in Kolhapur District** **91**
N.S. Jagtap, M.M. Ghatage, Y.S. Thorat

17. **An Analysis on the Pattern and Distribution of Fatal Injuries Among Homicidal Deaths in Kalaburagi: An Autopsy Based Study.** **98**
Umesh SR, Parvathy Jayapal, Deepak Suntnoore, Maqdoom SyedSyed Musab

18. **A Prospective Autopsy based Study on Estimation of Sex from the Sternal Parameters at Mahatma Gandhi Memorial Government Hospital, Trichy** **105**
Pary Prasath Mahendran, Arun Balan Mohan Kamaraj, Sakthivel Krishnan, Mithra Velusamy

19. **Poisoning deaths at a Medical college in Rural Area of Northern India: A Five-year Retrospective Autopsy-based Study** **113**
Vipan Bhandari, Nitin Malik, Kanika Kohli, K.K Aggarwal

20. ***Erratum*** **118**

Case Study

DOI: https://doi.org/10.37506/htffgv84

An Interesting Case of Homicide Disguised as an Accident: A Case Report

Abhishek Sharma[1], Kirti Parmar[2], Manoj Kumar Sharma[3]

[1]Senior Resident, Department of Forensic Medicine, Shri Lal Bahadur Shastri Government Medical College and Hospital, Mandi at Nerchowk, Himachal Pradesh, India, [2]Medical Officer (Specialist), Dr. R.K.G.M.C. Hamirpur, Himachal Pradesh, India, [3]Associate Professor, Department of Forensic Medicine, Shri Lal Bahadur Shastri Government Medical College and Hospital, Mandi at Nerchowk, Himachal Pradesh, India.

How to cite this article: Abhishek Sharma, Kirti Parmar, Manoj Kumar Sharma. An Interesting Case of Homicide Disguised as an Accident: A Case Report. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Homicide is defined as the killing of one human being by another human being and is one of the most heinous crimes that can be committed against a body. It is punishable by the highest penalty in many countries. The perpetrator wants to escape punishment after committing the crime. To do so, they try to find ways to protect themselves. The following is an interesting case of a 26-year-old laborer whose body was recovered by police in the evening hours of February 22, 2024in a secluded place. Police, including the deputy superintendent, visited the crime scene and questioned the victim's coworkers. Nobody suspected foul play. Police concluded the incident to be a case of an accidental fall leading to death. However, based on the autopsy findings and a crime scene visit by forensic pathologists, the case was relabeled as homicide.

Keywords: accident, crime scene, disguise, homicide, foul play

Introduction

Homicide is a leading cause of unnatural death[1], and cases of homicide are increasing worldwide. Death by homicide usually results from injuries sustained to the vital parts of the body. The most common body part involved in an accident or homicide is the head. Lacerations over the head can be caused by a fall from height or assault with a blunt weapon. They can appear incised and be confusing to a forensic pathologist. However, a careful examination of injuries can determine the exact manner of infliction.

Injuries sustained from a fall from height involve the bony prominences of the body and have a component of abrasion to them. Injuries caused by assault with a blunt weapon can be present anywhere on the body, have a component of contusion, and can illicit the pattern of the weapon used. In India, a total of 28,522 cases of murder were registered in2022[2].

The criminal who has committed a homicide wants to save himself and adopts various methods to do so. Concealment of a crime may include the burning of the corpse, running over it by train or

Corresponding Author: Abhishek Sharma, Senior Resident, Department of Forensic Medicine, Shri Lal Bahadur Shastri Government Medical College and Hospital, Mandi at Nerchowk, Himachal Pradesh, India.

E-mail: abhirpgmc@gmail.com

Submission date: June 8, 2025 **Acceptance date:** July 15, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

motor vehicle, dropping it from a height, or crushing it with a load[3]. Nevertheless, after a careful crime scene visit, thorough autopsy examination, and meticulous observation of external injuries, the exact manner of death can be ascertained.

Case Presentation

We present the case of a 26-year-old male whose body was recovered from a secluded place near a local river beside a retaining wall in the evening hours of February 22, 2024 near Nerchowk in the Mandi district of Himachal Pradesh, India. His jeanslay at the level of the knees, and stray dogs were eating his left lower limb. He was identified based on a mobile phone recovered from his pocket. He was a laborer by profession from Uttar Pradesh.

The crime scene was visited by the deputy superintendent of police and the station head officer of the local police station, and the case was concluded to be a fall from height leading to death.

A police inquest was conducted under section 174 of the Criminal Procedure Code (CrPC), and the body of the deceased was brought to the department of forensic medicine and toxicology at Shri Lal Bahadur Shastri Government Medical College and Hospital in Nerchowk, Mandi district for postmortem examination on February 23, 2024 at 03:15 PM.

After examining the crime scene photographs provided by the police and the injuries over the head and face of the deceased, it was decided that a visit to the crime scene would be made before conducting an autopsy.



Figure 1: Crime scene photograph furnished by police.

Crime scene visit observations:

- The height of the concrete wall was around 5 feet.
- There were some blood-stained stones of different sizes (police were advised to preserve them).
- Shrubbery at the place where the body was found was undisturbed.
- No drag marks were observed.

Relevent Autopsy Findings

External examination:

The body was stout, well-built, and measured 5 feet, 7 inches in length. The body was clothed in a blue and yellow checkered shirt, a black t-shirt, blue jeans lying at the level of knees, a black belt, and blue underwear. All clothes were soiled with dried, clotted blood, dirt, and dust.

Injuries were apparent over the head and face. The face was smeared with dried, clotted blood, and the right side of the face was grossly deformed. The body had cooled down to room temperature, and rigor mortis was in the passing-off stage. Hypostasis was not appreciable over the body, and there were no external signs of putrefaction. No ligature marks were present externally or internally.

Injuries:

External antemortem injuries

- There were 26 injuries over the body.
- There were 15 lacerations with contused margins over the head, face, both hands, and lower limbs. Some of the lacerations were:
    - Laceration with red contused margins, of size 5 cm x 2 cm and bone deep, present over the right side of forehead, along the midline and 5.5 cm above the glabella, obliquely oriented.
    - Laceration with red contused margins, of size 3 cm x 1 cm and bone deep, present over the right side of forehead, 0.2 cm lateral to the midline and 0.2 cm above the right supra-orbital ridge, obliquely oriented.
    - Laceration with red contused margins, of size 4 cm x 1.5 cm and bone deep, present over the right side of forehead, 8.8 cm lateral to the midline and 3 cm above the right supra-orbital ridge, obliquely oriented.
    - Laceration with red contused margins, of size 3.5 cm x 0.5 cm and bone deep,

present over the left side of the forehead, 9 cm lateral to the midline and 1.5 cm above the left supra-orbital margin, obliquely oriented.

- Laceration with red contused margins, of size 7 cm x 2 cm and bone deep, present over the left parietal region of scalp, 4.5 cm lateral to the midline and 6.5 cm above and lateral to the external occipital protuberance, obliquely oriented.

- There were 6 tramline contusionsover the back. The major tramline contusions were:
  - Tramline contusion, reddish-blue, of size 12 cm x 4.5 cm, present over the left sub-scapular region, 2 cm lateral to the midline and obliquely oriented.
  - Tramline contusion, reddish-blue, of size 7 cm x 3.5 cm, present over the right sub-scapular region, 2 cm lateral to the midline and obliquely oriented.
  - Tramline contusion, reddish-blue, of size 12 cm x 4.5 cm, present over the right sub-scapular region, 6 cm lateral to the midline and obliquely oriented.
- There were 3 abraded contusions over the bony prominences as mentioned below:
  - Abraded contusion, reddish-blue, of size 6 cm x 4 cm, present over the right side of the face, 5 cm lateral to the midline and 2 cm below the right eye.
  - Abraded contusion, reddish-blue, of size 5 cm x 1.5 cm, present over the supra-sternal notch.
  - Abraded contusion, reddish-blue, 2 in number, of size 0.5 cm x 0.5 cm each, present over the posterior aspect of base of proximal phalanx of right ring and middle finger.
- There were gross contusions over the anterior aspect of both legs as mentioned below:
  - Gross contusion, reddish-blue, present over an area of 28 cm x 10 cm, over the anterior aspect of right leg, with 4 lacerations of size 2 cm x 0.5 cm and skin deep, 3 cm x 1 cm and skin deep, 3.5 cm x 1 cm and skin deep & 2 cm x 0.5 cm and skin deep respectively, present over anterior aspect of middle and lower 1/3rd of right leg.
  - Gross contusion, reddish-blue, present over an area of 29 cm x 9.5 cm, over the anterior aspect of left leg, with 2 lacerations with red contused margins, of size 1.5 cm x 0.5 cm and skin deep & 2 cm x 1 cm and skin deep, respectively, present over anterior aspect of upper 1/3rd of left leg, and 1 laceration with red contused margin of size 1.5 cm x 0.5 cm and skin deep present over the anterior aspect of lower 1/3rd of left leg.



Figure 2: Multiple lacerations over the face and head of the deceased.



Figure 3: Gross deformity of the nose.

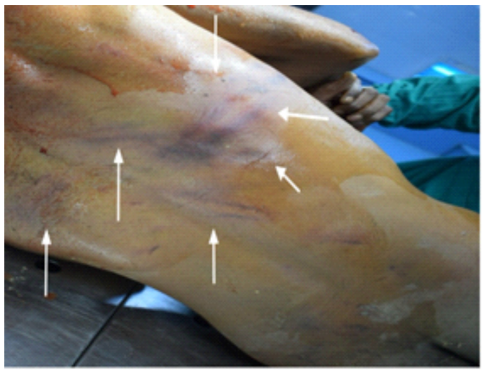


Figure 4: Multiple tramline contusions over the back.

External postmortem injuries

- There was a laceration over the anterior aspect of the left thigh with gnaw marks present over the bone (consistent with a canine bite).
- There was an abrasion over the right anterior superior iliac spine.

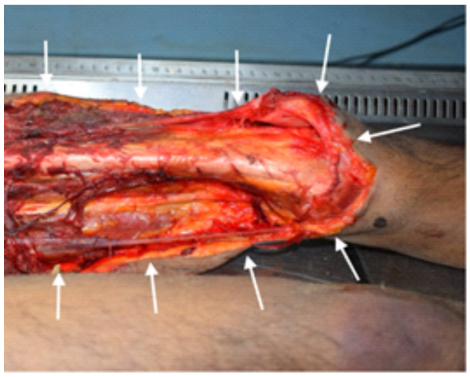


Figure 5: Postmortem laceration over the left thigh.

Internal examination:

On inspection of the scalp, a gross subgaleal hematoma was present over the bilateral frontal region. Both the right and left temporalis muscles were contused. A gross subarachnoid hemorrhage was present over the bilateral front oparietal region of brain.

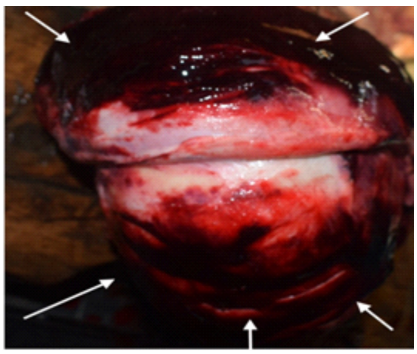


Figure 6: Subgaleal hematomaover the bilateral frontal region of the scalp.

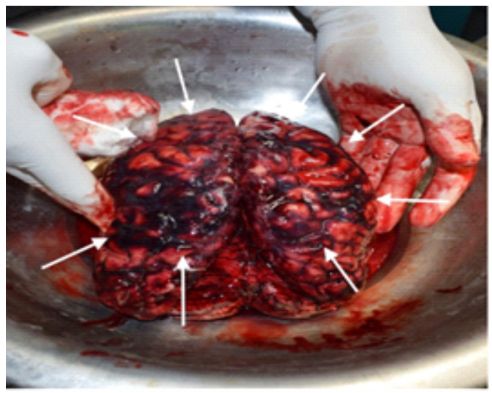


Figure 7: Subarachnoid hemorrhageover the bilateral frontoparietal region of brain.

Fractures:

There was a fracture of the nasal bone, a comminuted fracture of the shaft of the lower third of the left tibia and fibula, and a comminuted, depressed fracture of the right zygomatic bone, maxilla, orbit, and right anterior cranial fossa, along with an extravasation of blood in and around the fracture site.



Figure 8: Gross contusion with underlying fracture of the left leg.

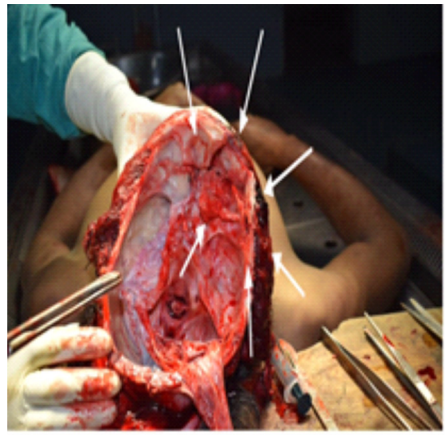


Figure 9: Comminuted, depressed fracture of right anterior cranial fossa.

Cause of death:

The cause of death issued was homicidal traumatic brain injury secondary to blunt trauma sustained in the head region. The time between injury and death was given as instantaneous. The time between death and postmortem was given as around 24–36 hours.

Samples preserved for analysis: Viscera and blood were preserved for chemical analysis, blood was preserved for cross-matching, the victim's clothes were preserved, and the sternum was preserved for DNA profiling. Nothing significant was found in an analysis of the samples preserved.

Based on the autopsy report, police registered a First Information Report u/s 302 of the Indian Penal Code. The police obtained the call records of the deceased. After two days, three accused (two males and one female)were arrested on the charge of homicide. All the accused confessed to the crime, as the victim had been caught with the female (the wife of one of the accused) in an objectionable state on February 21, 2024. The husband of the female and his brother initially punched and kicked the victim and beat him with sticks. The victim eventually lost consciousness from the sustained beating. The perpetrators put the victim in their car and dumped his body at the crime scene to disguise the case as an accidental fall. Finally, to make sure he would not survive, the accused hit the victim's head with a large stone and fled the crime scene.

The police recovered the weapons of offense, and the car used to dump the body. The blood stains recovered from the weapons and the car matched the blood type of the deceased.

Discussion

Any person who has committed a homicide will try to find ways to escape law enforcement agencies. They can try to disguise the homicide as a suicide or accident. A thorough and meticulous autopsy is required to ascertain the exact manner of death. The most common autopsy cases brought to most autopsy centers are accidental, and a case disguised as accidental can always confuse a forensic pathologist.

The injuries sustained in cases of fall from height include lacerations with abraded margins, different types of abrasions, present predominantly over the bony prominences and exposed areas of the body, contre-coup injuries, different fractures depending upon the part of body on which a person lands and the height from which an individual has fallen. In homicidal cases, the injuries like patterned contusions, injuries over the vertex of the head, lacerations with contused margins are found and these injuries can be present over the un-exposed areas of the body also. These injuries are usually present over a vital part of the body and are multiple due to multiple impacts over a part of the body.

Globally, the incidence of fatal head injuries due to assault is greater than that of non-fatal cases[4]. People are often unaware that an autopsy can make it easier for an investigating officer to find the culprit[5].

This case demonstrates the importance of a crime scene visit. In this case, the body of the deceased was found near a retaining wall with a height of only 5 feet. The injuries present over the body of the deceased were not consistent with a fall from such a small height. The reliability of the history provided to the forensic pathologist and the inquest conducted by the police were also questionable in this case. There were many patterned contusions over the back of the deceased, which further helped us to confirm the assault.

The authors, Pydiraju et al., reported a premeditated hit and run case with throttling[6].

In our case, the perpetrators committed the homicide and dumped the body in a secluded place to mislead the investigating agencies.

Conclusion

A careful observation of injuries is imperative in every case. Patterned injuries, if present, can tell investigators about an assault. Forensic pathologists should visit a crime scene as and when required and should not rely exclusively on the history provided by police and inquest papers. The history should be consistent with the findings observed at the time of examination. This can help us to determine the exact manner of death, even if the perpetrator has tried his/her best to disguise the crime.

No funding has been taken from any source.

Conflict of interest: None

References

1. Reddy KSN. *The Essentials of Forensic Medicine and Toxicology*. 26th ed. Hyderabad: K Suguna Devi; 2007. p. 251–2, 303–8.
2. National Crime Records Bureau. *Crime in India*. https://ncrb.gov.in/en [Accessed March 13, 2025].
3. Mant A. Postmortem injuries. In: Tedeschi CG, Eckert WG, Tedeschi LG. (eds.) *Forensic medicine: a study in trauma and environmental hazards*. Philadelphia: WB Saunders Company; 1977. p. 1063.
4. Chattopadhyay S, Tripathi C. Skull fracture and haemorrhage pattern among fatal and nonfatal head injury assault victims - a critical analysis. *Journal of Injury and Violence Research*. 2010;2(2):99–103.
5. Khurshid A, Ahmad H, Jaffry AA et al. A homicide in disguise: how the autopsy dug up clues. *Cureus*. 2022;14(5): e24691. DOI10.7759/cureus.24691.
6. Pydiraju Y, Sreedevi BR, Narendra B. Homicide by road traffic accident: a case report. *Journal of Evidence-Based Medicine and Healthcare*.2015;2(15):2196–2198.

Case Study

DOI: https://doi.org/10.37506/y6c1ys29

Concealment of Death in Blunt Thoracoabdominal Trauma

Abhishek Soni

3rd year Post graduate, Forensic Medicine and Toxicology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh

How to cite this article: Abhishek Soni. 3rd year Post graduate, Forensic Medicine and Toxicology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh. Indian Journal of Forensic Medicine and Toxicology/ Volume 19 No. 4, October-December 2025.

Abstract

Introduction: Blunt thoracoabdominal trauma is a common and potentially fatal injury mechanism, often resulting from vehicular accidents, assaults, or workplace incidents. In certain cases, efforts are made to conceal the true cause of death by providing misleading histories, which poses a significant challenge for forensic investigation.

Case Presentation: We report a case involving a 21-year-old male laborer found unresponsive in a factory premises. The initial history suggested a sudden cardiac death. However, detailed postmortem examination revealed multiple rib fractures, massive hemothorax, and lacerations of the liver and spleen, confirming death due to blunt thoracoabdominal trauma. The findings were incompatible with the alleged history, indicating an attempted concealment of the actual cause of death.

Discussion: This case highlights the forensic significance of discordant clinical histories and autopsy findings. Literature indicates that blunt force trauma, particularly involving noncompressible torso hemorrhage, remains a leading cause of early trauma-related mortality. Concealed homicides involving blunt trauma have been documented, emphasizing the need for systematic and multidisciplinary evaluation. Autopsy findings such as internal hemorrhage, organ laceration, and absence of external injuries must be carefully interpreted in such contexts.

Conclusion: This report highlights the indispensable role of forensic pathology in identifying concealed deaths due to blunt trauma. Accurate determination of cause and manner of death is essential not only for legal accountability but also for ensuring justice in cases where initial narratives are misleading.

Keywords: Abdominal trauma, Autopsy, Blunt force injury, Concealed death, Forensic pathology, Hemorrhagic shock, Thoracic trauma

Introduction

Blunt thoracoabdominal trauma is a significant cause of morbidity and mortality, commonly resulting from road traffic accidents, workplace injuries, falls, or physical assault. [1] It involves a forceful impact to the chest or abdomen, often damaging vital organs such as the lungs, liver, spleen, and large blood

Corresponding Author: Abhishek Soni, 3rd year Post graduate, Forensic Medicine and Toxicology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh.

E-mail: drabhisheksonimbbs@gmail.com

Submission date: Sep 15, 2024 **Acceptance date:** August 4, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

vessels. While the injuries themselves may be life-threatening, what complicates such cases further is when the true cause or manner of death is hidden or intentionally misrepresented. [2] Concealment of death—whether to avoid legal consequences, financial liability, or social stigma—poses a serious challenge in forensic investigations. [3]

Every death under suspicious or unclear circumstances requires a thorough and systematic evaluation. The first clues often come from the crime scene itself. The location, physical evidence, body position, and surrounding environment all offer important insights into what might have transpired. Even subtle signs—like traces of blood, disturbed clothing, or the arrangement of nearby objects—can help reconstruct the sequence of events. Witness statements, if available, can provide useful leads, but they must always be weighed against the physical findings.[4]

In such cases, the role of the forensic pathologist becomes crucial. A detailed autopsy can uncover internal injuries that may not be visible externally, revealing a hidden narrative that contradicts the alleged history. For instance, fractures, organ lacerations, and internal bleeding often point toward significant trauma that cannot be explained by natural causes. When such findings clash with the version of events provided by bystanders or family members, the possibility of concealment must be considered. [5]

Ultimately, the pursuit of truth in forensic medicine relies on a blend of science, experience, and critical thinking. By piecing together evidence from the scene and the body, forensic experts aim to establish what really happened—ensuring justice for the deceased and closure for their loved ones. In cases of concealed blunt thoracoabdominal trauma, this commitment to uncovering the truth becomes all the more essential. [6]

Case Report

A case was brought to the forensic department of a medical College Hospital of Central India for postmortem examination under suspicious circumstances, wherein the history provided by bystanders suggested a sudden, natural death—allegedly due to a cardiac event.

The deceased was a 21-year-old male employed as a laborer at a private industrial facility engaged in paper processing. He was responsible for operating trolleys used in the internal transport of raw materials. According to coworkers, he had been sleeping in the open premises of the facility. Following rainfall during the night, he reportedly moved to a sheltered area around 4:00 AM. At approximately 5:00 AM the next morning (15th June 2024), he was found unresponsive. Several vehicles, including trucks and trolleys, were stationed nearby at the time of the incident.

The initial narrative provided by associates at the scene claimed a sudden collapse suggestive of myocardial infarction. However, inconsistencies in the alleged timeline and circumstances, combined with the absence of medical history and the environment in which the body was discovered, raised suspicion. This prompted a detailed medicolegal autopsy, which ultimately unveiled such findings that effectively exposing an attempt to conceal the actual cause of death.

External Examination:

The body was that of an average-built adult male, received in a supine position on the autopsy table. He was dressed in a multicolored shirt and brown undergarments, both of which were intact and devoid of blood stains, straw, or foreign material. Rigor mortis was well established in all four limbs, and postmortem lividity was fixed over the posterior aspects of the body.

A reddish-tinged fluid was noted oozing from the nostrils and mouth—an important indicator suggestive of underlying thoracic trauma rather than natural cardiac arrest. A contused abrasion measuring approximately 3 × 2 cm was identified over the medial aspect of the right arm, situated about 7 cm below the shoulder joint. This injury, although subtle externally, pointed toward blunt force application and raised suspicion when viewed in the context of the internal findings. No other obvious external injuries or defense wounds were observed. (Figure 1-4)



Figure 1: External facial appearance of the deceased at the scene showing blood-stained nostrils and perioral region suggestive of internal thoracic injury; no visible external trauma over the face or head.



Figure 2: Full-body view of the deceased at the scene showing a horizontal contusion pattern over the anterior chest, suggestive of track-line injury consistent with blunt force trauma.



Figure 3: Contused abrasion measuring approximately 3 × 2 cm over the medial aspect of the right upper arm, located about 7 cm below the shoulder joint—indicative of localized blunt force impact.



Figure 4: Contused abrasion measuring approximately 3 × 2 cm over the medial aspect of the left upper arm, located about 5 cm below the shoulder joint—indicative of blunt force trauma on the contralateral limb.

Internal Examination:

On dissection of the thoracic cavity, fractures of the 4th, 5th, and 6th ribs on the left side were clearly visible. The left lung displayed a laceration over its anterior surface, and the pleural cavity was filled with a large volume of blood, indicative of a massive hemothorax. These injuries were severe and could not be attributed to any natural cause such as a myocardial infarction. Rather, they pointed toward significant mechanical trauma to the chest.

Examination of the abdominal cavity revealed approximately 1.5 liters of blood, confirming massive intra-abdominal hemorrhage. The liver and spleen were both lacerated, with visible tears along their anterior surfaces—again consistent with a high-impact blunt force injury. The stomach contained semidigested food, suggesting that the incident occurred within a few hours after the last meal. All internal organs were notably pale, corroborating the diagnosis of hypovolemic shock secondary to internal hemorrhage as the physiological cause of death. (Figure 5 & 6)

Taken together, the internal findings provided unequivocal evidence of fatal blunt thoracoabdominal trauma. The presence of multiple organ lacerations, fractured ribs, and hemothorax/intra-abdominal bleeding strongly contradicted the initial history of

sudden death due to heart attack, which typically lacks such traumatic signatures. The absence of any pre-existing natural cardiac pathology and the presence of focused, high-energy impact injuries led to the conclusion that the cause of death was traumatic in nature, rather than natural.



Figure 5: Internal examination showing lacerated liver and gallbladder with adjacent splenic involvement; extensive intra-abdominal hemorrhage evident, consistent with fatal blunt abdominal trauma.



Figure 6A: Lacerated spleen with surrounding clotted and free intra-abdominal blood, indicative of severe blunt force impact and massive hemorrhage. Figure 6B: Opened cranial cavity showing pale and intact brain tissue; systemic pallor of all organs observed, consistent with profound hypovolemic shock due to thoracoabdominal hemorrhage.

Discussion

The case report presents a compelling example of concealment of death in the context of blunt thoracoabdominal trauma, highlighting critical forensic and pathological considerations that align with established literature on traumatic mortality patterns and post-mortem findings. The findings of lacerated spleen with massive intraabdominal hemorrhage, combined with intrathoracic hemorrhage resulting in generalized organ pallor, demonstrate the lethal nature of combined thoracoabdominal injuries that characterize some of the most challenging forensic cases.

While abdominal injuries—such as lacerations to the liver or spleen—are more frequently associated with concealed trauma due to their internalized location, thoracic injuries can also go unrecognized, especially in the absence of external signs. Rib fractures, for example, may occur following significant blunt force trauma without corresponding abrasions or contusions on the overlying skin. This has been well documented in autopsy studies, where up to 27% of rib fractures were found in patients with no visible external injuries, particularly in younger or lean individuals with pliable thoracic walls. [3,7] Such findings emphasize the importance of thorough internal examination and imaging in suspected cases of concealed trauma. In this case, the presence of multiple rib fractures and lung laceration without prominent external trauma supports this pattern and reinforces the need for careful forensic evaluation when the alleged cause of death does not align with postmortem findings.

The pathological findings in this case are consistent with established mortality patterns in blunt trauma, where hemorrhagic shock remains a predominant cause of death. Current literature indicates that hemorrhage accounts for 30-40% of trauma mortality, with solid organ injuries being particularly lethal. [7] The splenic laceration observed in this case aligns with data showing that the spleen is the most commonly injured organ in blunt abdominal trauma, with mortality rates reaching 48.8% in patients with massive intraabdominal bleeding. [8,9] Studies have demonstrated that hemorrhage -induced hypotension predicts high mortality rates of up to 54%, and in cases of massive

hemothorax, uncontrolled bleeding remains the main cause of death. [10,11] The combination of thoracic and abdominal hemorrhage in this case represents what trauma literature terms "noncompressible torso hemorrhage," which contributes significantly to early mortality within the first six hours of injury. [12]

The forensic significance of this case extends beyond the immediate pathological findings to encompass broader issues of concealment in traumatic deaths. Research indicates that concealment occurs in approximately 8% of homicide cases, with blunt force trauma being the most common cause of death in concealed homicides. [13] The patterns observed in this case - massive internal hemorrhage with evidence of blunt trauma - are consistent with studies showing that death from head trauma accounts for about 40% of concealed homicide cases. [14] The challenge of distinguishing between accidental and intentional trauma in cases where concealment is suspected has been extensively documented, with delayed diagnosis occurring in up to 17.3% of trauma cases, often complicating forensic investigations. Modern forensic practice emphasizes the importance of multidisciplinary evaluation using novel radiological and analytical techniques to properly assess cases where concealment is suspected, as the methodology must be case-specific and comprehensive to ensure accurate determination of cause and manner of death.[7]

Conclusion

This case highlights the vital role of meticulous forensic investigation in unveiling concealed causes of death, particularly in instances of blunt thoracoabdominal trauma where misleading histories are provided. The discordance between the alleged natural cause and the significant internal injuries uncovered during autopsy—such as rib fractures, organ lacerations, and massive internal hemorrhage—illustrates how deliberate attempts to mask trauma can be exposed through systematic postmortem examination. The findings not only refuted the initial claim of cardiac arrest but also raised suspicion of possible foul play, and eventually highlighting the medico-legal responsibility to pursue the truth. This reinforces the need for vigilance, interdisciplinary coordination, and scientific rigor in all suspicious deaths to uphold justice and prevent wrongful conclusions.

Ethical Approval

The study was approved by the Institutional Ethics Committee of Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh vide letter no. IEC/2024/111 dated 03.01.2025

Conflict of interest: None

Sources of Funding: None

References

1. O'Rourke MC, Landis R, Burns B. Blunt Abdominal Trauma. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 July 17]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK431087/
2. Ghimire R, Acharya BP, Pudasaini P, Limbu Y, Maharjan DK, Thapa PB. Blunt Abdominal Trauma among Patients Admitted to the Department of Surgery at a Tertiary Care Centre: A Descriptive Cross-sectional Study. JNMA J Nepal Med Assoc. 2023 May;61(261):404–8.
3. Byard RW. Concealed Homicides—A Postmortem Study and Review. Am J Forensic Med Pathol. 2024 Mar;45(1):20–5.
4. Death Scene Investigation from the Viewpoint of Forensic Medicine Expert. In: Forensic Medicine - From Old Problems to New Challenges [Internet]. InTech; 2011 [cited 2025 July 17]. Available from: http://www.intechopen.com/books/forensic-medicine-from-old-problems-to-new-challenges/death-scene-investigation-from-the-viewpoint-of-forensic-medicine-expert
5. Menezes RG, Monteiro FN. Forensic Autopsy. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 July 17]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK539901/
6. Ling S, Kaplan J, Berryessa CM. The importance of forensic evidence for decisions on criminal guilt. Sci Justice J Forensic Sci Soc. 2021 Mar;61(2):142–9.
7. Marco CA, Snoad TBL, Poisson C, Flamm A. Delayed Diagnosis of Intracranial Trauma. Cureus. 15(10):e47738.
8. Roy P, Mukherjee R, Parik M. Splenic trauma in the twenty-first century: changing trends in management. Ann R Coll Surg Engl. 2018 Nov;100(8):650–6.

9. Shen X, Sun J, Zhang J, Ke L, Tong Z, Li G, et al. Risk Factors and Outcome for Massive Intra-Abdominal Bleeding Among Patients With Infected Necrotizing Pancreatitis. Medicine (Baltimore). 2015 July 17;94(28):e1172.
10. Heckbert SR, Vedder NB, Hoffman W, Winn RK, Hudson LD, Jurkovich GJ, et al. Outcome after hemorrhagic shock in trauma patients. J Trauma. 1998 Sept;45(3):545–9.
11. Siller J, Havlícek K. [Haemothorax after blunt thoracic trauma]. Rozhl V Chir Mesicnik Ceskoslovenske Chir Spolecnosti. 2009 May;88(5):277–81.
12. Patel N, Harfouche M, Stonko DP, Elansary N, Scalea TM, Morrison JJ. Factors Associated With Increased Mortality in Severe Abdominopelvic Injury. Shock. 2022 Feb;57(2):175.
13. Byard RW. Concealed Homicides-A Postmortem Study and Review. Am J Forensic Med Pathol. 2024 Mar 1;45(1):20–5.
14. De Matteis M, Giorgetti A, Viel G, Giraudo C, Terranova C, Lupi A, et al. Homicide and concealment of the corpse. Autopsy case series and review of the literature. 2021 [cited 2025 July 17]; Available from: https://cris.unibo.it/handle/11585/788837.

Case Study

DOI: https://doi.org/10.37506/3wsm1k91

A Retrospective Analysis of Medicolegal Autopsy Cases Conducted at Gims, Kalaburagi, Karnataka

Maqdoom Syed Syed Musab[1], Manish K[2], Deepak S[3]

[1]3 Year Post Graduate, Department of Forensic Medicine and Toxicology, Gulbarga Institute of Medical Sciences Kaladuragi, [2]Associate Professor and I/C HOD, Department of Forensic Medicine and Toxicology, Gulbarga Institute of Medical Sciences, Kalaburagi, [3]Assistant Professor, Department of Forensic Medicine and Toxicology, Gulbarga Institute of Medical Sciences, Kalaburagi.

How to cite this article: Maqdoom Syed Syed Musab, Manish K, Deepak S. A Retrospective Analysis of Medicolegal Autopsy Cases Conducted at Gims, Kalaburagi, Karnataka. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Background: Profiling of medico-legal autopsy cases is essential to prevent future casualties and accurately assess regional crime rates. At present, road traffic accidents remain a leading cause of fatalities. *Objective:* By creating a comprehensive profile of medico legal deaths, we aim to understand the underlying factors and develop effective strategies to prevent future fatalities.

Materials and Methods: A retrospective analysis was conducted on the autopsy cases which were brought to mortuary, Gulbarga Institute of Medical Sciences, Kalaburagi during the year 2023. Throughout this duration, a total of 924 medico legal autopsy cases were conducted.

Result: Out of 924 cases maximum number of deaths were in the age group of 21-30years(210) followed by 31-40 years(204), majority of victims were males (82%), in identified bodies 77.6% were Hindus, 13.85% Muslim, 9.64% others. In our study deaths due to RTA's formed majority of cases (336), followed by Poisoning (138), natural deaths (124), asphyxial deaths (108), railway deaths (81) and homicidal deaths (52).

Conclusion: In our record based study of medico legal autopsy cases- majority were in 3rd decade of life, males constituted more in number as compared to female, Hindus being majority in number formed bulk of cases. The present analysis reveals that road traffic accidents, particularly vehicular accidents, poisoning, natural deaths and asphyxia deaths are increasingly becoming the leading cause of death in medico legal autopsies.

Keywords: natural deaths, asphyxial deaths, homicide, poisoning, road traffic accidents, burns, electrocution.

Introduction

The Bharatiya Nagarik Suraksha Sanhita (BNSS) 2023 mentions the medico-legal post-mortem examinations for investigating suspicious deaths. Section 194 BNSS requires these examinations to identify the deceased when not known, to ascertain

Corresponding Author: Maqdoom Syed Syed Musab, 3 Year Post Graduate, Department of Forensic Medicine and Toxicology, Gulbarga Institute of Medical Sciences, Kalaburagi.

E-mail: syedmsb840@gmail.com

Submission date: May 11, 2025 **Acceptance date:** June 7, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

the time since death and to determine the cause of death in unnatural circumstances, ensuring justice and accountability[1]. The term autopsy originates from ancient word 'Autopsia' which is derived from 'Autos' i.e. 'Oneself' and 'Opsis' i.e. 'to see for oneself'. An autopsy is frequently done in cases of sudden death where a doctor is not able to give a death certificate or when death is believed due to unnatural cause[2]. The term Post-mortem examination is often used as a simile for autopsy, basically it is not. It means only what it says that the body was examined after death[3].

In India, medico-legal autopsies are essential components of forensic investigations and legal inquiries, especially in cases of unnatural or suspicious deaths. However, the way these cases are reported and analyzed varies widely across regions. These differences often reflect local social, economic, and cultural conditions, not just medical or legal factors.

Kalaburagi, in northern Karnataka, has a mix of urban growth, rural life, and busy highways these factors leads to a high number of medico-legal cases like accidents, suicides, and poisonings. Yet, there is limited detailed research on autopsy data from this region, especially regarding age patterns, seasonal trends, and causes of death. Most available studies focus on broader national data, leaving a gap at the local level.

To help fill this gap, the study looks back at medico-legal autopsy cases carried out at the Department of Forensic Medicine & Toxicology, Gulbarga Institute of Medical Sciences (GIMS), Kalaburagi, during 2023. By reviewing 924 cases from that year, it aims to understand the patterns and causes of death in the region and offer insights into the local medico-legal and public health landscape.

We hypothesize that certain patterns such as age group, gender distribution, cause, and manner of death are more commonly seen in medico-legal autopsies in Kalaburagi. By analyzing these cases, the aim of the study is to highlight local trends that may differ from those reported in other regions.

By offering a detailed, data-driven overview of the medico-legal deaths in Kalaburagi, this study aims to connect forensic findings with public health efforts, helping to improve both prevention strategies and investigative processes in the area.

Materials and Methods

This retrospective study included all cases of deaths brought for autopsy at mortuary of Gulbarga Institute of Medical Sciences, Kalaburagi, from January 1, 2023, to December 31, 2023. In this study, the emphasis has been put on to find the total number of death cases, the sex of the individuals, and the month-wise distribution. The cause of death variables analyzed includes age, sex, month of incidence, causative agent, and cause of death at autopsy. The data were collected, compiled and tabulated to determine the frequency and proportion of these fatalities, and the results were expressed in percentages.

Observations and Results

A total number of 924 autopsy cases were done during the study period of 01 year (2023), out of which 756(82%) were males and 168(18%) were females [**Fig 01**]. 718 cases were from the working age population (21-60 years of age) indicating that deaths predominantly affected the economically productive segment of the population. 11 cases were in the age group between 0-10 years, 87 cases were in the age group between 11-20 years and 108 cases were above 61 years of age[**Table No 01**].

Maximum number of death occurred in the month of December i.e. 100 cases whereas minimum number of deaths occurred in the month of January i.e.64 cases. [**Fig 02**]. This seasonal variation may reflect regional factors such as weather conditions, agricultural cycles, or festive periods influencing accident rates and other causes of death, a pattern that warrants further investigation.

Out of 924 cases, 834(90.36%) were identified, 89(9.63%) were unidentified. Of the identified 76.4% were Hindu and Muslims were (13.85%). In 9.63% cases religion could not be determined as they were unidentified bodies [**Fig 03**]. This demographic distribution aligns with the local population structure, reinforcing the representativeness of the data.

Major causes of death include Road traffic accidents (336), Poisoning (138), natural deaths (124), asphyxial deaths (108), railway deaths (81) and homicide (52). Other minor causes include snake bite

(33), self fall (28), electrocution (13), burn (7) and by lightning (2) [**Table No 02**]. The predominance of RTAs and poisoning highlights the ongoing public health challenges related to road safety and substance exposure in the region.

As per history, circumstantial evidences and postmortem findings, this study indicates that the predominant manner of death was accidental, with a total of 515 cases, whereas suicidal, natural, and homicidal deaths accounted for 233, 124, and 52 cases, respectively. [**Table No 02**]. This finding underscores the critical need for targeted preventive strategies focused on accident reduction and mental health interventions to address suicide rates.

One notable finding was the much higher number of deaths in December compared to other months something not commonly seen in similar studies from other regions which suggests there might be unique seasonal factors at play in Kalaburagi. Also, the relatively large share of railway-related deaths (8.77%) stands out, likely due to the district's major railway junctions.

Overall, these results shed light on the patterns of death in Kalaburagi and highlight key areas where public health and safety efforts could be improved.

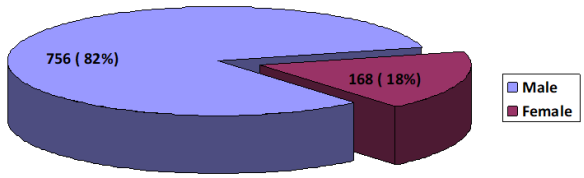


Fig 1: **sex wise distribution**

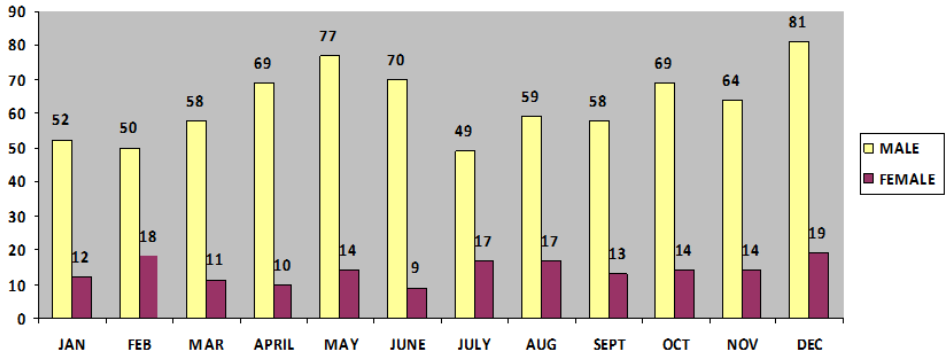


Fig 2: **Month Wise Distribution**

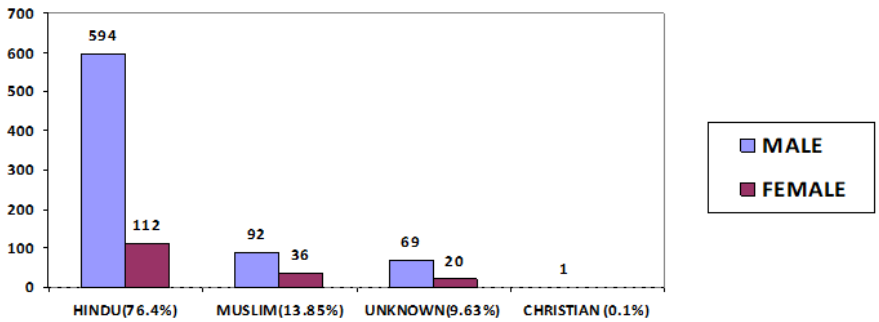


Fig 3: **Religion Wise Distribution**

Table 1: Age Wise Distribution

AGE	TOTAL	PERCENTAGE
<01	04	0.4%
1-10	07	0.75%
11-20	87	9.41%
21-30	210	22.7%
31-40	204	22.07 %
41-50	171	18.5%
51-60	133	14.3%
61-70	77	8.3%
71-80	26	2.8%
81-90	05	0.5%
Total	924	100%

Table 2: Distribution of cause of death cases according to manner of death.

CAUSE OF DEATH	ACCIDENTAL		SUICIDAL		HOMICIDAL		NATURAL		TOTAL	PERCENT-AGE
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE		
RTA	**288** (31.1%)	**48** (5.19%)	-	-	-	-	-	-	336	36.1%
POSIONING	**10** (1.08%)	-	**94** (10.17%)	**34** (3.67%)	-	-	-	-	138	14.71%
SNAKE BITE	**21** (2.27%)	**13** (1.4%)	-	-	-	-	-	-	34	3.57%
HANGING	-	-	**71** (7.68%)	**21** (2.27%)	-	-	-	-	92	9.95%
DROWNING	**11** (1.19%)	**5** (0.5%)	-	-	-	-	-	-	16	1.73%
ELECTROCU-TION	**12** (1.29%)	**1** (0.1%)	-	-	-	-	-	-	13	1.4%
LIGHTNING	**2** (0.2%)	-	-	-	-	-	-	-	2	0.2%
NATURAL	-	-	-	-	-	-	103 (11.14%)	**19** (2.05%)	122	13.4%
ASSAULT	-	-	-	-	40 (4.32%)	12 (1.29%)	-	-	52	5.95%
SELF FALL	**27** (2.9%)	**1** (0.1%)	-	-	-	-	-	-	28	3.03%
RAILWAY	**60** (6.49%)	**11** (1.19%)	**10** (1.08%)	-	-	-	-	-	81	8.76%
BURNS	**4** (0.43%)	-	-	**3** (0.32%)	-	-	-	-	7	0.75%
SEPSIS	-	-	-	-	-	-	**2** (0.2%)	-	2	0.2%
OTHER ACCIDENT	**1** (0.1%)	-	-	-	-	-	-	-	1	0.10%
TOTAL	436	79	175	58	40	12	105	19	924	100%
	515 (55.73%)		233 (25.2%)		52 (5.62%)		124 (13.41%)			

Discussion

This retrospective study was conducted in the Department of Forensic Medicine & Toxicology at the Gulbarga Institute of Medical Sciences, Kalaburagi, in 2023. The findings from this study were compared with similar research from other regions to identify both commonalities and differences. This comparison aimed to explore variations in trends, causes, patterns, and outcomes in forensic and toxicological cases, providing a broader context for the observed data.

During the study period, a total of 924 medico-legal autopsies were performed, of which 756 cases (82%) were male and 168 cases (18%) were female. These findings are consistent with the studies conducted by Narendra Singh et al[2], Rahul Agarwal et al[3], Anand Mugadlimath et al[5], Jigneshkumar B Patel et al[6]. The higher incidence of male cases can be attributed to traditional gender roles, which place men at greater risk of accidents, violence, and stress, and can also increase their susceptibility to addiction and risk-taking behaviors.

Our study revealed that the majority of victims (210) fall within the 21-30 age range, followed closely by those in the 31-40 age range (204 cases). This finding aligns with previous research conducted by

Narendra Singh et al[2], Rahul Agarwal et al[3], Soni Verma[4], Anand Mugadlimath et al[5] and Paresh V Chandegara et al[7]. The high representation of young adults can be attributed to their recent entry into significant life responsibilities, including career establishment, romantic relationships, marriage, and stressful situations.

Our study's demographic analysis revealed that 76.4% of the identified individuals were Hindu, 13.85% were Muslim, and 9.63% remained unknown. These findings are consistent with the results reported by Anand Mugadlimath et al[5]. The observed distribution may be attributed to the prevailing population dynamics and demographic characteristics of India.

In our study most common manner of death was accidental (515) followed by suicides (233) followed by natural (124) followed by homicidal (52) which was consistent with the study conducted by Rahul Agarwal et al[3], Chandru K, Rudramurthy[8] and Khaja Azizuddin Junaidi et. al[9].

In our study road traffic accidents (RTAs) were the leading cause of death, accounting for 336 cases (36.1% of total cases). Poisoning cases were the second most common, with 138 cases (14.71% of total cases), followed by natural deaths, which comprised 122 cases (13.4% of total cases), and hanging cases, which accounted for 92 cases (9.95% of total cases). Notably, our findings diverge from those reported by Rahul Agarwal et al[3], which identified burns cases as second most common cause of death and Anand Mugadlimath et al[5], which identified burns cases as a more common cause of death than RTAs. The high incidence of RTAs in our study may be attributed to the fact that Kalaburagi is a district headquarters surrounded by highways, resulting in a higher frequency of accidents. The tertiary care center in the region likely receives a disproportionate number of accident victims.

In the present study, the total numbers of poisoning cases conducted were 132 cases (14.71% of total cases). Interestingly, poisoning was the second leading cause of death, with farmers being disproportionately represented among the victims. This may be due to the financial instability and lack of knowledge about precautionary measures related to agricultural poisons.

Natural deaths were the third most common cause of death in our autopsy cases which comprised 122 cases (13.4% of total cases). Notably, a significant proportion of natural death cases involved beggars, which may be related due to the presence of tourist attractions and railway junctions in Kalaburagi.

In our study maximum number of death occurred in the month of December i.e. 100 cases whereas minimum number of deaths occurs in January i.e. 64 cases.

Conclusion

This study looked at medico-legal autopsy cases from Gulbarga Institute of Medical Sciences, Kalaburagi, and provided important insights into the causes and patterns of deaths in the area. The results highlight the need for focused efforts by policymakers, law enforcement, and the community to reduce accidental deaths, suicides, and other medico-legal cases.

One key takeaway is the importance of health awareness programs that address stress and mental health, along with education on traffic rules and safe driving. Improving road conditions, enforcing safety laws, boosting emergency response, and setting up trauma care centers are also essential steps, especially as the population grows and risks increase.

This study's findings help connect forensic data with public health, pointing to local issues that need attention. However, there are some limitations since it's a retrospective study, it depends on existing records that might be incomplete or inconsistent, especially for unidentified bodies. Also, since the data comes from just one center, the results might not apply everywhere. We didn't explore social or environmental factors in depth, which could also affect death patterns.

Looking ahead, future research should include studies that follow cases over time and involve multiple centers to get a broader picture. It would also be helpful to study social and behavioral factors more closely and to look into seasonal trends that might be unique to this region.

Overall, this study provides valuable local data that can help improve forensic investigations and

public health efforts in Kalaburagi, stressing the need for coordinated action to reduce preventable deaths and keep the community safer.

Conflict of interest: None

Source of funding: Nil

Ethical Clearance: Permission was not taken from IEC as it was a record based retrospective study without involving any live subjects or experimentation.

References

1. Section 194 of THE BHARATIYA NAGARIK SURAKSHA SANHITA, 2023 – BNSS. Available at: https://vidhiadda.com/section-194-of-the-bharatiya-nagarik-suraksha-sanhita-2023-bnss/
2. Narendra Singh, Nidhi C, et al. Profile of pattern of post-mortem cases in mortuary of district hospital (associated with government medical college, Vidisha). *IP International Journal of Forensic Medicine and Toxicological Sciences*, 2021: 6(2): 40-42.
3. Rahul Agrawal, P. S. Thakur, et al. Demographic Profile of autopsy in Indore region- One year prospective Study. *Indian journal of forensic and community Medicine,* October- December, 2018; 5(4): 245-249.
4. Soni Verma. Profile of Autopsy cases at Government Medical College Kanpur: A Retrospective Study. *Medico Legal Update*/ volume 24 No 1, January-March 2024.
5. Anand M, Shivanand K et al. Profile of Medicolegal Autopsy Cases at Tertiary care Centre in Bagalkot, Karnataka. *Indian journal of forensic Medicine and Toxicology. April-June 2017*; 10(2): 63-65.
6. Jigneshkumar B Patel, Paresh V C, et al. Profile of autopsy cases at New Civil Hospital, Surat: a retrospective study. *International Journal of Medical Science and Public health.*2016; 5(online first).
7. Paresh V Chandegara, Jignesh B Patel, et al. Profile of autopsy cases at tertiary care center during pandemic. *IP International Journal of Forensic Medicine and Toxicological Sciences* 2023; 8(2): 60-64.
8. Chandru K, Rudramurthy. Profile of Autopsy Cases at District Hospital, South India in Pandemic Year 2020. *Indian Jornal of Forensic Medicine and Toxicology*. 2022; 16(4):24–7. doi:10.37506/ijfmt.v16i4.18518.
9. Khaja AzizuddinJunaidi et. al. Profile of medico legal autopsy cases at tertiary care centre in Belagavi, Karnataka: A one year retrospective study. Medico legal Update, 2020; 20(1): 170-174.

Case Study

DOI: https://doi.org/10.37506/bg316464

Determining the Manner of Fatal Cut Throat Injury and its Challenges: A Case Report

Gebremariam Tewelemedhin Gebremariam[1], Charles Karangwa[2], Innocent Nkurunziza[3], David Ishimwe[4]

[1]Forensic Medicine Specialist, Medical Doctor, Rwanda Forensic Institute, Kigali; Rwanda, [2]Director General, Pharmacist, DEA, PhD, Post Doc Fellowship of Clinical Toxicology, Rwanda Forensic Institute, Kigali; Rwanda, [3]Forensic Medicine Division Manager, Medical Doctor, MPH in Epidemiology, Rwanda Forensic Institute, Kigali; Rwanda, [4]Bsc nursing, MPH in Global health, Rwanda Forensic Institute, Kigali; Rwanda.

How to cite this article: Gebremariam Tewelemedhin Gebremariam, Charles Karangwa, Innocent Nkurunziza. Determining the Manner of Fatal Cut Throat Injury and its Challenges: A Case Report. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Cutthroat wounds, uncommon and complex neck injuries inflicted by sharp objects, often share similar characteristics, which makes it difficult for forensic experts to ascertain the cause of death. This case report presents the autopsy findings of a 19-year-old girl who died of a sharp force injury to the neck. Autopsy revealed a horizontal cutthroat wound at the front of the neck, a deep wound on the left shoulder, several superficial injuries on the face, and extensive bloodstains on the neck, chest, and hands. This report emphasizes the necessity of a thorough and multidisciplinary approach in the postmortem examination of cutthroat injuries, stressing the importance of a detailed evaluation of wound features, associated injuries, and contextual evidence to accurately determine the manner of death.

Keywords: Cutthroat injury, Forensic autopsy, Manner of death

Introduction

Fatal cut-throat injuries, though uncommon, are intricate wounds inflicted by sharp objects on the neck, posing distinct challenges in forensic medicine, especially when determining the cause of death.[1] Such injuries can result from various situations, including murder, suicide, and accidents, and often share similar characteristics.[2] To ascertain the manner of death in these cases, a thorough examination of several elements including wound characteristics, evidence from the crime scene, the circumstances surrounding the death, and the medical and psychosocial background of the victim is necessary.[3] Fatal cutthroat injuries are infrequent and complex, often sharing similar features, making definitive generalizations difficult.[4,5] Consequently, each case is unique and demanding, necessitating forensic experts to perform thorough and comprehensive

Corresponding Author: Gebremariam Tewelemedhin Gebremariam, Forensic Medicine Specialist, Medical Doctor, Rwanda Forensic Institute, Kigali; Rwanda.

E-mail: gtewe21@gmail.com

Submission date: June 23, 2025 **Acceptance date:** July 25, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

postmortem investigations to accurately distinguish them.[6,7]

This report details the case of a 19-year-old female who was killed by a sharp force wound to the neck, highlighting the challenges in determining the manner of death and emphasizing the need for a multidisciplinary approach in forensic investigations of cutthroat cases, which will enhance current understanding and ultimately aid in the quest for justice.

Case Presentation

The body of a 19-year-old right-handed girl was discovered in a forested area of Rwanda, dressed, and lying on her back, with clothing in disarray and signs of injury to her neck. The deceased was seen alive and in good health just four hours earlier, walking with her former boyfriend around the area where her body was found. She resided with her parents, helped with household tasks, and had no known psychiatric illnesses or other chronic health problems. At the death scene, significant bloodstains on the front and back of her neck, shoulder, and upper chest, as well as on her face and back of her head, were noted, and the ground beneath her head, neck, and shoulder was heavily stained by blood. No sharp weapons were discovered at the scene.

An autopsy was conducted at the Rwanda Forensic Institute one day after she was discovered dead and revealed a female body dressed with upper wear, bra, and panty. Clothing covering the neck, shoulders, and chest was heavily stained with blood (Figure 1). Extensive wet and dried bloodstains were present on the face, front and back of the neck, front of the right and left shoulders, palms and dorsum of the left and right hands, and back of both forearms. A horizontal deep cut wound, measuring 06 cm × 3.5 cm × 02 cm, after apposition of the margins, was detected on the front of the neck, below the thyroid cartilage with neck structures severed to the level of the cervical vertebrae. The wound traversed the midline, was slightly elevated on the left side of the neck, and tailed on the right side of the neck with clean cut edges (Figure 2). A 01 cm × 0.5 cm superficial cut wound was detected on the right end of the cutthroat wound. An ovoid puncture wound, 01 cm in diameter was found on the front of the medial aspect of the left shoulder, 07 cm lateral to the jugular notch (Figure 2). Additionally, there was a 03 cm × 01 cm abrasion on the left zygomatic area of the face, a 01 cm × 0.5 cm abrasion on the lateral side of the left periorbital area, a 1.5 cm × 01 cm abrasion on the left cheek area of the face, and a 01 cm × 0.5 cm abrasion on the right cheek area of the face. No bloodstain was found over the abdomen or lower limbs.

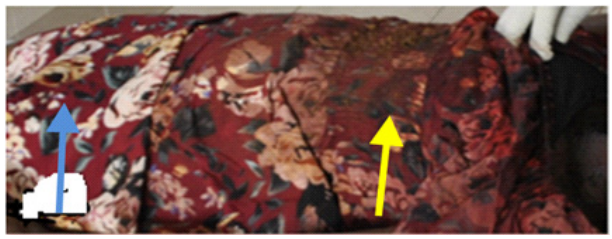


Figure 1: Body of the homicide cutthroat victim on the autopsy table showing clothing covering the neck, shoulders, and chest showing extensive blood stains (yellow arrow) with scanty blood stains over the pelvic area and lower extremities (blue arrow).

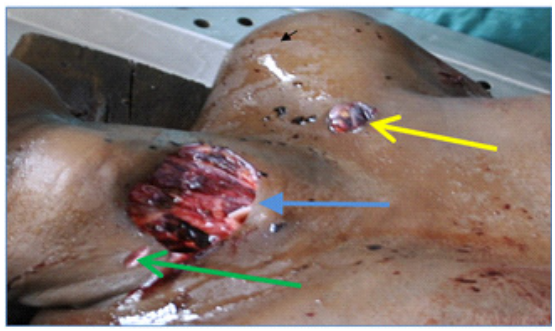


Figure 2: The body in supine position in the autopsy table showing horizontal cutthroat wound located onthe lower third of the necksevering the front neck structures deep to the cervical bone (blue arrow) with anassociated punctured stab wound on front of the left shoulder (yellow arrow) and a dissection artefact (green arrow).

The external genitalia showed no signs of trauma and samples were collected from representative vaginal sites to test for spermatozoa and other seminal contents, which yielded negative results. The blood, urine, and bile samples collected for toxicological analysis showed no positive findings. Other external and internal autopsy examinations revealed no injuries or abnormalities. The autopsy report revealed that sharp force neck injury was the cause of death, and the manner of death was classified

as a homicide. The investigation report on the crime showed that it identified six people, including her ex-boyfriend who was seen walking with her, as suspects, and they collectively confessed murdering her by inflicting a severe neck wound with a sharp object inflicting from behind and they were found guilty and handed down the sentences.

Discussion

Fatal cutthroat wounds, categorized as accidental, suicidal, or homicidal, are uncommon and complex and often share a variety of similar characteristics posing significant challenge to differentiate them.[4,8] Consequently, each case is unique and intricate, necessitating comprehensive and multidisciplinary forensic approach.[7,9] The few reported homicidal cutthroat injuries also show variations in wound characteristics, indicating the challenging nature of these injuries.[10,11] This study discusses the case of a young girl who was killed by a cutthroat wound accompanied by a puncture wound and several abrasion injuries.

A case of homicidal cutthroat injury reported by Vidanapathirana et al. described an oblique cutthroat wound that started just below the left ear and ended at the middle third of the right side of the neck, with extensive blood spurting reaching the abdomen and no associated injuries.[12] This contrasts with our study, which found a horizontal cutthroat wound on the lower third of the neck accompanied by a superficial cut at the right end of the cutthroat wound and associated injuries to the face and the left shoulder. The notable differences between these two studies, particularly in the location and lay of the cutthroat wound patterns and the presence of associated injuries and hesitation cut, are likely due to physical dynamics during infliction of the injury. Thus, generalizing cutthroat wound characteristics is challenging and tailored case-specific examinations and analyses are recommended. However, two of these studies revealed similarities in that no weapon was found at the scene, the cutthroat injuries were deep severing the trachea and esophagus, toxicology results were negative, and suspects who confessed to the murder were identified, which also shows the variable and multidisciplinary nature of fatal cutthroat injury investigation.

Homicidal cutthroat wounds typically feature a single deep incision that can reach the neck bones without any shallow cuts. In contrast, suicidal cut injuries often include hesitation marks alongside the final, deeper cut, primarily to gauge pain tolerance, and these injuries usually do not penetrate deeply into vertebral bones. Nevertheless, some homicidal cutthroat injuries may exhibit superficial cuts at the ends of the final incision, and suicidal cutthroat injuries can occur without hesitation marks.[9,13] In this particular case, the cutthroat wound penetrated deeply into the vertebral bones with a superficial cut at its right end, a situation unlikely to be self-inflicted due to its depth. Additionally, the status of clothing alignment and associated injuries can provide insights into the context and intent behind cutthroat wounds. The associated injuries are typically superficial and within the victim's reach in suicidal cases, whereas it is deeper in homicide cases, usually with disturbance of clothing.[14] In this instance, the presence of disarrayed clothing, deep puncture wounds, multiple abrasions on the face, and superficial cuts indicate a struggle or additional violence during the attack, which is consistent with homicide.

Fatal cutthroat injuries can also be distinguished on the basis of their location and direction. Homicidal cutthroat injuries inflicted from behind begin below either ear, depending on the assailant's handedness, and traverse the midline horizontally or obliquely below the thyroid cartilage, whereas they are located above the thyroid cartilage and directed upward from their starting point in suicidal cases.[15] In our case, the wound was horizontal, with a slightly elevated left end crossing the midline on the lower third of the neck, indicating a homicidal attack from behind. However, homicidal cutthroat injuries inflicted from the front can mimic self-inflicted wounds, and accidental cutthroat injuries can exhibit varied wound patterns, resulting in unusual wound characteristics. consequently, thorough and multidisciplinary postmortem investigation is crucial to corroborate evidence and address any atypical circumstances.[16]

Bloodstain patterns can offer crucial insights into the characteristics of cutthroat injuries. In instances where the wounds are self-inflicted, blood may flow downward from the neck, particularly if the individual is standing or seated during or after the

incident, or it may be splattered on nearby mirrors, as victims often use mirrors to ensure precision. Conversely, in homicide scenarios, blood typically splatters on the back and front of the neck, shoulders, and upper chest if the victim is placed on the back.[17,18] Our study found extensive bloodstains on the back and front of the head, neck, upper chest, and both hands, indicating that she was attacked from behind and pulled to lie on her back. Furthermore, the prominent bloodstains on both hands suggest that she attempted to defend herself with her hands.

Another key factor in determining the nature of a cutthroat injury is examining the psychosocial background of the deceased, the circumstances surrounding death, and the scene of death.[15,19] In this instance, the victim, a girl with no history of psychiatric issues, was last observed walking with her ex-boyfriend, who, along with his friends, admitted to killing her, and no sharp weapon material was detected at the death scene examination, all of which support the conclusion of homicide.

In summary, when fatal cutthroat injuries occur without witnesses, they can arouse significant suspicion among family members or investigators, potentially resulting in social unrest and injustice if not handled properly.[1,15,20] Furthermore, the patterns of cutthroat injuries are complex requiring meticulous and through postmortem examinations.[7,21,22] In this study, we used patterns of the cutthroat wound and associated injuries, circumstantial and crime scene evidences, patterns of the blood stains to classify it as homicidal cutthroat injury.

Conclusion

This case report describes a tragic event involving a homicidal cut-throat injury that resulted in the death of a 19-year-old girl, emphasizing the vital need for thorough investigation. A meticulous assessment of the wound's characteristics, related injuries, bloodstain patterns, and death scene, along with circumstantial evidence and personal history, is essential for accurately determining the nature of fatal cutthroat injuries. This report highlights the necessity for forensic experts to perform comprehensive autopsies and collaborate with other specialists to accurately determine the manner of death in cases involving sharp-force neck injuries. Additionally, the successful prosecution of perpetrators underscores the significance of extensive forensic evidence for achieving justice in such complex cases. This report serves as a reminder of the devastating effects of violent crimes, and the ongoing need for effective preventive measures and support systems within communities.

Acknowledgments: We acknowledge the administration of the Rwanda forensic Institute for the permission to conduct this case report.

Statements and declarations:

Ethical approval: The outlined study protocol for this case report obtained ethical approval from the research project committees operating within the Rwanda Forensic Institute (RFI).

Informed consent: This study is a case report and informed consent for the study was obtained from the family of the deceased.

Compliance with ethical standards: The study was carried out following the ethical standards of the Declaration of Helsinki (Finland).

Conflict of interest: Payment/services info: no financial support was received from any organization for this study.

Financial relationships: there is no financial relationships at present or within the previous three years with any organizations that might have an interest in this study.

Other relationships: there is no other relationships or activities that could appear to have influenced this study.

Data availability: Not applicable.

Clinical trial number: Not applicable.

References

1. Cirielli V, Cecchetto G, Narayanasamy M, et al. Atypical suicide by single incising cut to the throat without hesitation marks: case report and review of the literature. Legal Medicine 2024; 70: 102468.
2. Farkašová Iannaccone S, Ginelliová A, Farkaš D, et al. Suicide by sharp force associated with major self-mutilation and self-cannibalism. Forensic Sci Med Pathol 2024; 20: 1538–1542.

3. Anas M, Mannan R, Khan ZM. Understanding the Mode and Factors Influencing Cut-Throat Injuries in a Tribal-Dominated Population in Eastern India. Cureus 2023; 15: e45481.
4. Askay M, Vural T, Ketenci HÇ, et al. Investigation of Deaths Due to Cut-Throat Injuries: A 10 Year Autopsy Study: Retrospective Research. | EBSCOhost. 2024; 21: 79.
5. Kkv R, K P, Sk G, et al. An Atypical Suicidal Cut Throat Injury- Mechanism Uncovered after Injury Interpretation. Journal of Indian Academy of Forensic Medicine 2022; 44: 102–104.
6. Valente-Aguiar MS, Falcão AC, Magalhães T, et al. A Cruel Homicide via Blades of a Young Boy under Custody in a Juvenile Correctional Unit. Forensic Sciences 2021; 1: 4–7.
7. Ambika P, Rathod JBS, Anupama K, et al. Suicidal Cutthroat Injuries-A Study on 20 Cases. Int J Trop Med 2024; 19: 101–106.
8. Fronczek J, Boer HH de. Neck Trauma Deaths. In: Forensic and Legal Medicine. CRC Press, 2023.
9. Alsenaidi L, A. Abder-Rahman H, M. Al-Abdallat I, et al. Characteristics of Homicidal Cut-Throat Death Cases. AJFSFM 2024; 6: 181–191.
10. AlGheryafi ZF, Alnasser FF, Almukhtar FH, et al. Differentiating suicide from homicide in sharp-force fatalities with stab and/or incised wounds: A scoping review. Legal Medicine 2024; 67: 102388.
11. Behera C, Sikary AK. Homicide by Multiple Fatal Methods: A Study From South Delhi, India. J Interpers Violence 2021; 36: 7855–7865.
12. Vidanapathirana M, Samaraweera JC. Homicidal Cut Throat: The Forensic Perspective. J Clin Diagn Res 2016; 10: GD01-02.
13. Bhattarai D, Upadhyaya S, Banstola H, et al. Alcohol Withdrawal Presenting with Cut Throat Injury during COVID-19 Lockdown: Case Reports from Nepal. Case Rep Psychiatry 2023; 2023: 5514321.
14. Barranco R, Gaggero G, Salomone A, et al. An unusual case of cut throat injury and poisoning by penconazole - suicide or homicide? Medico-legal considerations and toxicological aspects. Clin Ter 2025; 176: 4–7.
15. Akber EB, Nowshin I, Jahan I. Forensic Profiling of Cut Throat Wounds. Mymensingh Med J 2021; 30: 106–110.
16. Singh BK, Tomar JS, Sharma L, et al. Suicidal cut-throat with medico-legal masquerades: case illustration and review of the literature. Egypt J Forensic Sci; 13. Epub ahead of print 30 September 2023. DOI: 10.1186/s41935-023-00363-0.
17. Mileva B, Goshev M, Georgieva M, et al. Accidental Cut-Throat Injury by a Broken Glass: Bloodstain Pattern Analyses and Autopsy Findings. Cureus 2024; 16: e51945.
18. Bose PK, Ray D, Biswas P, et al. Suicidal cut-throat wound during LSD intoxication. Clin Case Rep 2021; 9: e05100.
19. Kuang Joo L, Abdullah N, Abd Mutalib NS, et al. Cut-throat Injury in Attempted Suicide Amidst Coronavirus Disease 2019 (COVID-19). Cureus 2023; 15: e49949.
20. Chahal PS, Aggarwal AD, Walia DS, et al. Accidental Fatal Neck Injury from Mechanical Saw: A Case Study and Forensic Perspective. Victimology 2024; 10: 29–31.
21. Farkašová Iannaccone S, Ginelliová A, Farkaš D, et al. Suicide by sharp force associated with major self-mutilation and self-cannibalism. Forensic Sci Med Pathol 2023; 20: 1538–1542.
22. Said AAM, Abdelaal GMM, Omran BHF, et al. Forensic Perspective of Injuries with Particular Focus on Incised Wounds. Zagazig University Medical Journal 2024; 0: 0–0.

Case Study

DOI: https://doi.org/10.37506/qs8jx241

Shades of Blue: A Case Series of Acquired Methemoglobinemia

Rashmi Ranjan Pattanayak[1], K Smita Reddy[2], Biswabikash Mohanty[3], Pravat Ranjan Sahoo[4], Amol Parate[5]

[1]Associate consultant, department of critical care medicine, Utkal hospital, Bhubaneswar, Odisha, [2]Consultant, department of oncoanesthesia, Utkal hospital, Bhubaneswar, Odisha, [3]Senior consultant, department of critical care medicine, Utkal hospital, Bhubaneswar, Odisha, [4]Associate consultant, department of critical care medicine, Utkal hospital, Bhubaneswar, Odisha, [5]Consultant, department of critical care medicine, NSH hospital, Nagpur Maharasthra.

How to cite this article: Rashmi Ranjan Pattanayak, K Smita Reddy, Biswabikash Mohanty. Shades of Blue: A Case Series of Acquired Methemoglobinemia. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Methemoglobinemia is a significant medical condition that can result from oxidative stress in the body. It leads to reduced oxygen delivery to tissues due to altered hemoglobin, which decreases the ability to bind oxygen. As a result, a patient's oxygen saturation on pulse oximetry may be lower, even when supplemental oxygen is provided, while the SaO2 measured through blood gas analysis remains normal. This discrepancy creates a saturation gap. The treatment for methemoglobinemia is methylene blue, which can reverse the condition. We reported a case series of methemoglobinemia due to pesticide exposure. Both patients had low oxygen saturation despite oxygen therapy. On co-oximetry, we confirmed methemoglobinemia. Both patients responded well to methylene blue. Recognisingthat methemoglobinemia can be fatal if not addressed promptly is crucial. Early diagnosis through co-oximetry is essential. By identifying the saturation gap, healthcare providers can initiate early treatment with methylene blue, leading to better patient outcomes.

Key Words: Methemoglobinemia, Pesticide, Methylene blue

Introduction

Methemoglobinemia is an important condition that can result from oxidative stress in the body. When the ferrous ion in the heme molecule of hemoglobin is oxidized into a ferric ion, methemoglobinemia occurs. This leads to the formation of dyshemoglobin, which has a diminished capacity to bind oxygen, subsequently reducing the blood's ability to carry oxygen effectively[1]. The resulting decrease in oxygen delivery can lead to tissue hypoxia, which we must address proactively. In healthy individuals, the concentration of methemoglobin in the blood is typically below 2%. This condition can present as either congenital or acquired. Methemoglobinemia is relatively uncommon. The prevalence of methemoglobinemia is around 0.035%[1]. Risk factors are hospitalized

Corresponding Author: Rashmi Ranjan Pattanayak, Associate consultant, department of critical care medicine, Utkal hospital, Bhubaneswar, Odisha.

E-mail: rashmipattanayak88@gmail.com

Submission date: March 13, 2025 **Acceptance date:** April 23, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

patients, benzocaine-based anesthetics, infants and premature infants, the elderly, and G6PD (glucose-6-phosphate-dehydrogenase) deficiency. G6PD (glucose-6-phosphate-dehydrogenase) deficiency can induce methemoglobinemia by inhibiting NADPH-flavine reductase, which prevents methemoglobin reduction. Methylene blue, which is the treatment of choice for methemoglobinemia, is contraindicated in individuals with G6PD deficiency due to the risk of hemolytic anemia and potential for worsening methemoglobinemia. Long-term implications of methemoglobinemia can be cyanosis, fatigue, and in severe cases, seizure, coma, and death if not treated effectively. The mortality rate of methemoglobinemia can vary, but levels above 70% are often associated with death, while those below 70% can be treated successfully with methylene blue. A significant number of acquired cases are drug-related, often linked to medications such as dapsone, local anesthetics, and antimalarials. In this case series, we will explore two patients who developed acquired methemoglobinemia due to pesticide exposure, focusing on their treatment journey and the steps taken for effective management.

Case Report

Case-1

A 30-year-old female with no significant medical history was admitted to the Intensive Care Unit (ICU) two days after ingesting a pesticide. She presented with symptoms of dizziness and headache. After initial treatment at a local hospital, she arrived at the ICU exhibiting tachypnea and tachycardia, with an oxygen saturation of 78% in room air, measured by pulse oximetry. She received oxygen through a non-rebreathing mask at a flow rate of 10 liters per minute. On sampling for lab analysis, her blood appeared dark brown (Fig 1). The initial arterial blood gas analysis showed an oxygen saturation (sO2) of 90% and a partial pressure of oxygen (pO2) of 72.3 mm Hg while the patient was on room air. Additionally, the methemoglobin level was found to be 59%, later confirmed by a co-oximeter. Given a more than 10% saturation gap, the patient was treated with 2 mg/kg of methylene blue. After treatment, her urine changed to a blue hue (Fig 2). The patient's G6PD level was normal. A repeat arterial blood gas analysis performed two hours later revealed a methemoglobin level of 8.7%, and her oxygen saturation improved to 90% as measured by pulse oximetry. Further inquiry revealed that she had ingested an insecticide known locally as "ZERO INSECTICIDE," which contains the compound emamectin benzoate, recognized for causing methemoglobinemia. The patient's initial laboratory values are shown in Table 1. After two hours, the patient's oxygen saturation dropped again to 78%, and an arterial blood gas (ABG) analysis indicated a methemoglobin level of 20%. The patient received a repeat dose of methylene blue at 2 mg/kg. To address the potential for a rebound increase in methemoglobin levels, an infusion of methylene blue was initiated at a rate of 10 mg/hour for 24 hours. After six hours, the methemoglobin level decreased to 2%. After 24 hours, the patient's oxygen saturation improved as measured by pulse oximetry; however, the hemoglobin level decreased, and liver function tests (LFTs) worsened, with an increase in indirect bilirubin levels indicating hemolysis. A peripheral blood smear revealed fragmented cells, and lactate dehydrogenase (LDH) levels were elevated, as shown in Table 2. Methylene blue was discontinued, and after two days, the patient's liver function tests returned to normal. The patient was discharged after six days. At a follow-up appointment two months later, the patient was doing well.

CASE 2

A 38-year-old female was admitted with an alleged history of pesticide (PERFECT ZENE and ANTH 505), which contains chlorpyriphos and cypermethrin, and nitrate compound. She was treated at a local hospital and shifted to the ICU. On arrival, the patient was tachypneic, with a heart rate of 60 beats per minute, and room air saturation of 82%. Arterial blood gas analysis showed SO2 of 97%, PO2 of 80 mmHg, and methemoglobin % of 30.7, which was later confirmed by cooximetry. The patient's blood was found to be a chocolate color (Fig 3). A serum choline esterase level was sent, and a G6PD level was sent(found out to be normal). Atropine infusion was started, and methylene blue at a dose of 2mg/kg body weight was administered. After methylene blue, the urine changed to a bluish hue(Fig 4). After 3 hours, the patient's saturation improved to 94% on 3 lt of oxygen, and the methemoglobin

percentage on arterial blood gas analysis was found to be 4.1%. Initial lab values are as follows (Table 4). The patient was having tachycardia and tachypnoea and was restless and agitated, probably because of atropine. The patient also received Vitamin C as an antioxidant. Gradually atropine was stopped, and the patient clinically improved, subsequently discharged on day 7 of admission. On follow-up,the patient was doing fine after 30 days.



Figure 1 shows dark brown blood on the left picture due to methemoglobinemia in case 1



Figure 2 shows a blue hue in urine due to the methylene blue treatment in case 1



Figure 3 shows chocolate blood on the left picture due to methemoglobinemia in case 2



Figure 4 shows a bluish hue in urine after methylene blue in case 2

Table-1

LAB TESTS	LAB VALUE ON ADMISSION DAY	LAB VALUE ON THE NEXT DAY OF ADMISSION
HB/TLC/TPC	10/18K/2.6L	9.7/17K/3.0L
UREA/CREAT	21/0.68	14.5/0.55
NA/K	138/3.79	139/4.1
BILLIRUBIN (T/D/I)	1.1/0.5/0.6	
SGOT/PT	38/18	
ALBUMIN	4.34	
CHOLINE ESTERASE	6356(4650-10440)	

Table 1 shows the Initial lab value on admission day, and the next day, the serum cholinesterase level was normal in case 1

Table-2

LAB INVESTIGATIONS	LAB VALUES AFTER ADMINISTRATION OF METHYLENE BLUE
HB/TLC/TPC	8.2/20K/3.0L
UREA/CREATININE	17/0.49
BILLIRUBIN(T/D/I)	3.40/0.9/2.48
SGOT/PT	37/12.6
LDH	433.6 (NORMALLY LESS THAN 247)

Table 2 shows lab values of hemolysis after administration of methylene blue, also peripheral smear showing fragmented red cells in case 1.

Table-3

LAB INVESTIGATION	LAB VALUES ON DAY OF ADMISSION	LAB VALUES ON THE NEXT DAY OF ADMISSION
HB/TLC/TPC	12.9/12k/2lakh	11.2/16k/2.3lakh
UREA/CREAT	34.8/0.51	30.7/0.59
NA/K	137/4.40	133/3.75
BILLIRUBIN(T/D/I)	0.97/0.16/0.81	
SGOT/PT	16.2/12.6	
ALBUMIN	4.59	
CHOLINE ESTERASE	740.9(4650-10440)	

Table 3 shows the initial lab values of case 2. The cholinesterase level was low because it was an organophosphorus poison.

Table-4

DRUG GROUP	EXAMPLE OF DRUGS CAUSING METHEMOGLOBINEMIA
Local anesthetics	Benzocaine (often used in endoscopicprocedures)
Nitrates	Nitroglycerin,inhaled nitric oxide, Nitroprusside, oral nitrates, amyl-nitrate
Antibiotics	Dapsone
Other drugs	Rasburicase (especially in G6PD deficiency)
Environmental causes	fertilizers, herbicides, Plastic (various types), Paints, and rubber

Table 4 shows common drugs causing methemoglobinemia.

Discussion

Methemoglobinemia is a rare disorder where hemoglobin's iron changes from the ferrous to the ferric state, impairing its ability to bind oxygen. This condition shifts the oxygen-hemoglobin dissociation curve to the left, reducing oxygen delivery to tissues and resulting in hypoxia and functional anemia, even with normal hemoglobin levels[2]. Understanding its health implications is crucial.

Methemoglobinemia is classified into two types: congenital and acquired. Acquired methemoglobinemia is more common and results from exposure to substances that oxidize hemoglobin. In contrast, congenital methemoglobinemia is caused by genetic factors, primarily mutations in the CYB5R3 gene. Hereditary forms lead to NADH-cytochrome reductase deficiency. Acquired methemoglobinemia usually stems from specific drugs or toxins that oxidize hemoglobin from its ferrous (Fe2+) to ferric (Fe3+) form. A table listing common drugs that contribute to this condition is provided (Table 4).

The clinical manifestations of methemoglobinemia vary according to the percentage of methemoglobin in the blood[3]. Levels between 3% and 15% are typically asymptomatic. However, mild symptoms may occur when levels rise to between 20% and 30%, including fatigue, rapid breathing, shortness of breath, increased heart rate, anxiety, dizziness, nausea, and vomiting. At levels above 40%, more severe symptoms can manifest, such as seizures, coma, arrhythmias, and even death. Diagnosis is confirmed through co-oximetry, but healthcare professionals may suspect methemoglobinemia based on three key indicators[3].

1. **Refractory Hypoxia**: This condition is suspected in patients with an oxygen saturation level between 82% and 86% and who are receiving 100% oxygen, provided there are no other identifiable causes of their hypoxia.

2. **Cyanosis-Saturation Gap**: The presence of central cyanosis in patients with an oxygen saturation level between 80% and 90% may suggest the possibility of methemoglobinemia.

3. **Brown Blood Color**: Blood may exhibit a chocolate brown appearance. If a sample is placed on white gauze, it will remain brown when dry, in contrast to deoxygenated blood, which turns red upon oxygenation.

Methemoglobinemia is diagnosed using co-oximetry, which measures light absorption at four wavelengths: 600 nm (carboxyhemoglobin), 631 nm (methemoglobin), 660 nm (deoxyhemoglobin), and 940 nm (oxyhemoglobin). This method can identify disorders like carboxyhemoglobinemia and methemoglobinemia.[4] A "saturation gap" of over 5% between co-oximetry and pulse oximetry readings may indicate methemoglobinemia.

The primary treatment for methemoglobinemia is supportive care and discontinuing any offending drugs. Methylene blue is the definitive treatment, helping convert methemoglobin back to its non-oxidized form. It is recommended for symptomatic patients, especially when methemoglobin levels exceed 30%, but is contraindicated in those with G6PD deficiency and should be used cautiously due to possible serotonin syndrome. The standard dosage is 1-2 mg/kg intravenously over five minutes, with effects often seen within minutes and cyanosis typically resolving in an hour. A second dose may be necessary if cyanosis persists after 60 minutes. Rebound methemoglobinemia can occur within 12 hours, potentially requiring continuous infusion. For patients with G6PD deficiency, alternatives like high doses of vitamin C or riboflavin may be needed.

For cases that do not improve with methylene blue treatment, the next options to consider are hyperbaric oxygen therapy (HBOT), plasmapheresis, or exchange transfusion[6]. Although several published case reports on the use of HBOT exist, there are no clear recommendations for its application[7]. Additionally, HBOT may not be available at all medical centers, and the dosing and treatment protocols are not well-defined. The efficacy of hyperbaric oxygen remains unproven. In a systematic review, therapeutic whole blood exchange (TWBE) demonstrated a survival rate of 81.6% in patients who were refractory to methylene blue[8]. While TWBE shows promising efficacy, it has some limitations, including the need for reliable blood bank support and the complexity of the procedure, especially if specialized exchange equipment is unavailable. The appropriate volume to be exchanged and the number of sessions required have yet to be validated. Furthermore, complications such as hypotension can occur during the procedure, requiring close monitoring in an intensive care unit (ICU).

Similar to our case, these are some case reports that benefited from methylene blue treatment due to acquired methemoglobinemia.

Liwen Zhao and colleagues managed a case of acquired methemoglobinemia caused by a nitrobenzene compound, treating it with methylene blue and other antioxidants[2].

Tarun George and associates handled a case of methemoglobinemia resulting from insecticide poisoning, using methylene blue, vitamin C, and riboflavin for treatment[3].

Angela Mauro and her team reported two cases of methemoglobinemia resulting from nitrate ingestion from vegetable sources, both successfully managed with methylene blue[4].

Giulia Cannata and colleagues documented a case of methemoglobinemia resulting from consuming homemade vegetables, which was effectively treated with methylene blue.[5]

Lakshmikanthcharan Saravanabavan and his team managed three cases of methemoglobinemia due to pesticide poisoning. In addition to methylene blue, they used hyperbaric oxygen therapy and exchange transfusion for refractory cases, with successful outcomes[6].

Ida Ivek and her team managed a case of methemoglobinemia due to poisoning from an unknown substance, successfully treated with methylene blue and other antioxidants[7].

Mona J. Malik and colleagues reported a case of methemoglobinemia linked to substance ingestion at a rave party, which was successfully treated with methylene blue[8].

Conclusion

Methemoglobinemia is a rare disorder characterized by elevated levels of methemoglobin, an oxidized form of hemoglobin that cannot bind oxygen. This results in an inadequate supply of oxygen to tissues. There are two types of methemoglobinemia: genetic and acquired. Genetic methemoglobinemia is chronic and typically presents as cyanosis (a bluish discoloration of the skin) without other symptoms. In contrast, acquired methemoglobinemia, which is often

caused by exposure to certain drugs and chemicals, is acute and can be potentially life-threatening. Symptoms of methemoglobinemia vary depending on the level of methemoglobin present and may include fatigue, dizziness, altered consciousness, seizures, and even coma. It should be suspected when a person shows low oxygen saturation on pulse oximetry and has chocolate-colored blood. Methemoglobin levels may need to be monitored for up to 7 days as they can remain elevated. Diagnosis is confirmed through co-oximetry, a specialized test to measure blood methemoglobin levels. Treatment involves supportive care and discontinuing the use of the offending substance. Emergency responders should have antidotes such as methylene blue and vitamin C, as acquired methemoglobinemia can be serious.

Clinical Significance

1. Methemoglobinemia is a rare acquired condition caused by herbicide ingestion.
2. Careful clinical judgment is required for accurate diagnosis and treatment.
3. Methylene blue is used to treat methemoglobinemia, but it may lead to hemolytic anemia.

Declaration of Conflicting Interests:

The authors declared no potential conflicts of interest regarding this article's research, authorship, and/or publication.

Patient Consent Statement

We hereby confirm that we have obtained written informed consent from the patients in these case reports for publication of their clinical information.

Funding: The authors did not receive any financial support for this research, authorship, or publication.

References

1. Chowdhary, S. *et al.* Risk of Topical Anesthetic–Induced Methemoglobinemia: A 10-Year Retrospective Case-Control Study. *JAMA Intern. Med.***173**, 771–776 (2013).
2. Zhao, L. *et al.* Case report: Methemoglobinemia caused by nitrobenzene poisoning. *Front. Med.***10**, (2023).
3. George, T., Shaikh, A. I., Thomas, L. & Kundavaram, A. P. Severe methemoglobinemia due to insecticide poisoning. *Indian J. Crit. Care Med. Peer-Rev. Off. Publ. Indian Soc. Crit. Care Med.***18**, 113–114 (2014).
4. Mauro, A. *et al.* An acquired acute methemoglobinemia from dietary sources: Case reports and literature review. *Emerg. Care J.***17**, (2021).
5. Cannata, G. *et al.* The Dose Makes the Poison: A Case Report of Acquired Methemoglobinemia. *Int. J. Environ. Res. Public. Health***17**, 1845 (2020).
6. A Case Series of Acquired Methemoglobinemia Due to Pesticides: Conventional to Novel Therapies. https://www.ijccr.org/abstractArticleContentBrowse/IJCCR/31803/JPJ/fullText.
7. Successful treatment of methemoglobinemia in an elderly couple with severe cyanosis: two case reports | Journal of Medical Case Reports | Full Text. https://jmedicalcasereports.biomedcentral.com/articles/10.1186/1752-1947-6-290.
8. Methemoglobinemia: A Case Report - PubMed. https://pubmed.ncbi.nlm.nih.gov/38021620/.

Case Study

DOI: https://doi.org/10.37506/78k1t886

Incidental Detection of Foreign Body (bezoar) inside the Stomach in Fatal Poisoning Cases: Reporting of a Series of Cases with Rare and Unusual Autopsy Findings

Mandal S. Anindya[1], Abhijeet Bhardwaj[2], Chandan Bandyopadhyay[3]

[1]3rd year Junior Resident, Department of Forensic and State Medicine, Medical College, Kolkata, [2]2nd year Junior Resident, Department of Forensic and State Medicine, Medical College, Kolkata, [3]Professor and Head, Department of Forensic and State Medicine, Medical College, Kolkata & In-charge of Kolkata Police Morgue.

How to cite this article: Mandal S. Anindya, Abhijeet Bhardwaj, Chandan Bandyopadhyay. Incidental Detection of Foreign Body (bezoar) inside the Stomach in Fatal Poisoning Cases: Reporting of a Series of Cases with Rare and Unusual Autopsy Findings. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

A bezoar is an accumulation of undigested foreign material in the gastrointestinal tract, which can lead to serious, life-threatening conditions. While bezoars are often associated with mental disorders such as pica, they are also found in individuals without such histories. In many cultures, including rural India, bezoars are believed to possess medicinal properties, such as the ability to neutralize poisons, including snake venom. Traditional healers, known as "Ojha," use bezoars as a form of treatment despite the lack of scientific evidence supporting their efficacy.

This case series presents two incidents where bezoars were discovered postmortem. The first case involves a 9-year-old boy who succumbed to snakebite poisoning, and the second case involves a 1-year 6-month-old child who died from paraquat poisoning. Both deaths occurred at a government hospital, and during the autopsy, bezoars were unexpectedly found in the stomachs of both individuals. This finding highlights the continued belief in the curative properties of bezoars despite their lack of medicinal value in modern medicine.

Keywords: bezoar, gastroenterology, postmortem examination, ancient toxicology.

Introduction

Bezoars are conglomerates of indigestible materials that accumulate within the gastrointestinal tract[1,2]. Historically, they were esteemed in various cultures for their purported medicinal properties, particularly as universal antidotes against poisons, including snake venom. However, contemporary medical understanding recognises that bezoars, typically composed of substances like hair, fibres, or plant material, lack scientific efficacy in neutralising toxins[3,4,5]. The standard treatment for venomous snake bites is the prompt administration of antivenom, accompanied by supportive care in a medical facility. Similarly, paraquat poisoning necessitates immediate

Corresponding Author: Mandal S. Anindya, 3rd year Junior Resident, Department of Forensic and State Medicine, Medical College, Kolkata.

E-mail:

Submission date: Jun 17, 2025 **Acceptance date:** July 7, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

medical intervention due to its high toxicity[6,7]. This report discusses two rare cases where bezoars were incidentally discovered in the stomachs of deceased individuals who succumbed to snakebite and paraquat poisoning, respectively.

Case histories:

Case 1: A 9-year-old boy was bitten on his left ankle by an unidentified snake while playing in a field. He was initially treated at Srerampore Walsh Super Speciality Hospital and subsequently transferred to the Medical College and Hospital, Kolkata, on the same day. Despite medical efforts, he expired four days later, and a post-mortem examination was conducted at the Kolkata Police morgue. In this case, a relative of the deceased stated that before being taken to the hospital for treatment, the deceased was initially taken to a local traditional healer or Ojha. It was only when his condition deteriorated that he was taken to the hospital.

Case 2: A 1-year-6-month-old male child was admitted to the Medical College and Hospital, Kolkata, following the homicidal ingestion of paraquat poison administered by his mother. The child was brought to the hospital by his father, but unfortunately passed away five days later. A post-mortem examination was performed at the Kolkata Police morgue. In this case, such history like taken to local traditional healer or Ojha was unclear and incomplete.

Autopsy findings:

Case 1:

External Examination:

Peripheral intravenous lines were present on the dorsum of both wrists and in both cubital fossae, with a central line in the right internal jugular vein.

A stitched wound with two sutures was located 2 cm below the umbilicus along the midline of the anterior abdomen, likely indicating a peritoneal dialysis port.

Two puncture wounds, spaced 1.5 cm apart vertically, were observed medially on the left ankle, situated 3.5 cm proximal and anterior to the tip of the left medial malleolus.

Both conjunctivae were congested, and the pupils were fixed and dilated.

Bluish discoloration was noted on the fingertips and nail beds bilaterally.

Internal Examination:

Diffuse blood extravasation surrounded the puncture wounds over the left medial malleolus.

Extensive blood extravasation was present in the retropharyngeal and prevertebral spaces of the neck, as well as the retroesophageal space.

Diffuse blood extravasation was noted around the lesser curvature of the stomach.

All organs exhibited significant congestion, with marked medullary haemorrhage in both kidneys.

The brain was congested and oedematous.

Yellowish-brown fluid was found in both pleural cavities, indicating pleural effusion.

Upon dissecting the stomach, a 300-gram greenish-yellow, solid yet soft, roundish mass was discovered, seemingly composed of mud, sand, and fibrous plant material.





Fig. 1: Showing the body of the deceased in case-1





Case 2:

External Examination:

Peripheral intravenous lines were present on the dorsum of both wrists, with a central line in the left femoral vein.

Erosion and ulceration were noted on the inner aspects of the lips, gums, and tongue.

Both conjunctivae were congested, and the pupils were fixed and dilated.

Bluish discolouration was observed on the fingertips and nail beds bilaterally.

Internal Examination:

All organs were congested, with fibrosis noted in both lungs and cortical haemorrhage in both kidneys.

Oesophageal corrosion was evident.

Upon dissecting the stomach, a 200-gram yellowish, solid yet soft, roundish mass was found, seemingly composed of mud and sand, accompanied by gross submucosal haemorrhage.





Fig 8: showing the body of the deceased of case -2

Fig 9: shows the corrosion of the lips and gum. Fig 10: subcapsular haemorrhage on the diaphragmatic surface of liver

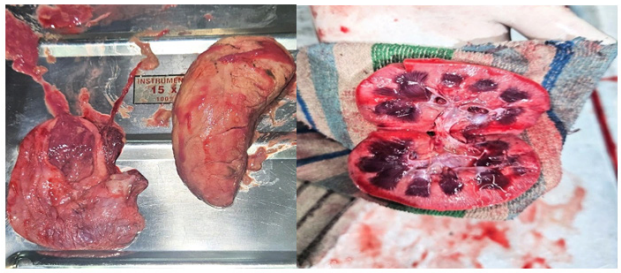


Fig 11: shows a corticomedullary haemorrhage on the kidney. Fig 12: shows the stomach with the whole bezoar



Fig 13: weights of the Bezoar. Fig 14: shows the cross-section of the Bezoar.

Microscopic Examination:

Under an optical microscope, the bezoar revealed the presence of glass particles, which appeared as transparent, irregularly shaped, and highly refractive structures. The glass particles exhibited varying thickness and texture, reflecting light in distinctive patterns. Their presence suggests possible ingestion of glass-containing materials, either accidentally or intentionally. This unusual finding necessitates further investigation into the patient's medical history and potential exposure to foreign materials.

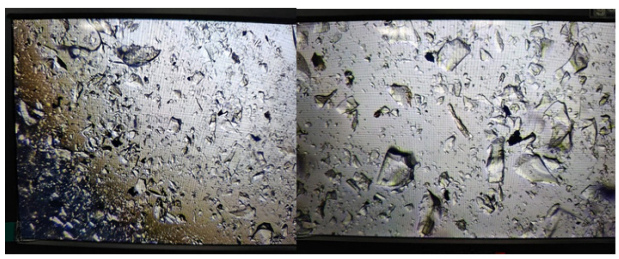


Fig. 15 & Fig 16, show varying thicknesses, irregular shapes, and highly refractive glass particles.

Discussion

In these cases, the incidental discovery of bezoars during post-mortem examinations suggests the possible ingestion of herbal concoctions or traditional remedies, possibly administered in an attempt to counteract the effects of snake venom or paraquat poisoning. Bezoars are typically classified based on their composition[3]:

Phytobezoars: Composed of indigestible plant fibres.

Trichobezoars: Comprised of hair.

Pharmacopoeias: Formed from medications.

Foreign Body Bezoars: Resulting from the ingestion of foreign materials.

The presence of materials such as mud, sand, and fibrous plant matter in the bezoars of both cases aligns with the characteristics of phytobezoars and foreign body bezoars. The formation of such bezoars can lead to gastrointestinal complications, including obstruction, ulceration, or perforation[8-12].

Cultural practices in various regions, including parts of India, involve the use of traditional remedies believed to neutralize poisons. These remedies may consist of plant-based concoctions or other substances administered orally. However, the efficacy of such treatments is not supported by scientific evidence and may delay the administration of appropriate medical care, thereby exacerbating the patient's condition[5].

The ingestion of indigestible materials as part of these traditional practices can lead to bezoar formation. In the context of acute poisoning, the presence of a bezoar may complicate the clinical picture, potentially diverting attention from the primary toxicological emergency. This underscores the importance of healthcare.

Conclusion

Bezoars, historically believed to possess medicinal and detoxifying properties, continue to be associated with traditional healing practices in certain cultures. However, their efficacy in treating snake bites or poisoning lacks scientific validation. In these rare post-mortem cases, bezoars were incidentally discovered in the stomachs of the deceased, suggesting the possible ingestion of traditional remedies containing indigestible materials. The presence of glass particles within the bezoar further indicates the potential consumption of foreign substances, either accidentally or intentionally.

These findings highlight the risks associated with superstitious treatments, which may not only be ineffective but also contribute to additional health complications. Delayed medical intervention due to reliance on such remedies can worsen the prognosis in cases of envenomation or toxic ingestion. This underscores the need for increased public awareness regarding the importance of evidence-based medical treatments and the potential dangers of traditional but scientifically unproven antidotes.

Consent: Written informed consent for publication of clinical details, post-mortem findings, and microscopical images was obtained from the autopsy surgeon, investigating police personnel, and the relative of the deceased.

Conflict of interest: The authors have no conflict of interest in this case report

Ethical clearance: Ethical clearance is obtained from the Institutional Ethics Committee.Date: 17/06/2025

Reference no. : MC/KOL/IEC/2789/06/2025

Source of funding: None

References

1. R.S. Williams. The fascinating history of bezoars. Med J Aust. 1986 Dec;145(11-12):613-4.
2. Anna Ryś, Bartłomiej Siek, Jacek Sein Anand. Bezoars in history--not only a perfect antidote. Przegl Lek. 2012;69(8):638-41.
3. Andrus CH, Ponsky JL. Bezoars: classification, pathophysiology, and treatment. Am J Gastroenterol. 1988; 83:476-478.
4. Gürses N, Gürses N, Ozkan K, Ozkan A. Bezoars--analysis of seven cases. Z Kinderchir. 1987;42:291–292.

5. Mikaili Peymanet, Shayegh Jalal. Ethnopharmacology and historical folk medicine of bezoar stone and its relationship to modern trichobezoar concept. roavs.2011; 1(9): 567-572.
6. Masaya HYPERLINK "https://www.clinicalkey.com/"Iwamuro, Haruo Urata et all. Ultrastructural analysis of a gastric persimmon phytobezoar. Clin Res Hepatol Gastroenterol. 2014-09-01;38(4):85-87.
7. Sanders MK. Bezoars: from mystical charms to medical and nutritional management. Pract Gastroenterol 2004;18:37—50.
8. Iwamuro M, Kawai Y, Shiraha H, Takaki A, Okada H, YamamotoK. In vitro analysis of gastric phytobezoar dissolubility byCoca-cola, coca-cola zero, cellulase, and papain. J Clin Gastroenterol 2013 [in press].
9. Krausz MM, Moriel EZ, Ayalon A, Pode D, Durst AL. Surgical aspects of gastrointestinal persimmon phytobezoar treatment.Am J Surg 1986;152:526—30.
10. Holloway WD, Lee SP, Nicholson GI. The composition and disso-lution of phytobezoars. Arch Pathol Lab Med 1980;104:159—61.
11. Maki T, Suzuki N. Experimental formation of persimmon-bezoar. Tohoku J Exp Med 1965;86:168—77.
12. Gaya J, Barranco L, Llompart A, Reyes J, Obrador A. Persimmonbezoars: a successful combined therapy. Gastrointest Endosc.2002;55:581—3.

Case Study

DOI: https://doi.org/10.37506/ypy75276

Suicide by Charcoal Burning in a Patient on Zolpidem Therapy: A Case Report

J.S.D. Peiris[1], Rahimi R.[2]

[1]Acting Consultant Forensic Pathologist, Ministry of Health, Sri Lanka, MBBS (Colombo, Sri Lanka), MD in Forensic Medicine (Colombo, Sri Lanka), [2]Associate Professor at Department of Forensic Pathology, Faculty of Medicine, Universiti Teknologi MARA Sungai Buloh Campus, Malaysia, MD (USU Indonesia), Master of Pathology (Forensic Pathology) University of Malaya, Malaysia.

How to cite this article: J.S.D. Peiris, Rahimi R. Suicide by Charcoal Burning in a Patient on Zolpidem Therapy: A Case Report. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Background: Charcoal burning causes death through carbon monoxide (CO) poisoning, leading to hypoxia and fatal pathological changes. Zolpidem, a hypnotic for insomnia, can short term and long-term side effects. Combined with psychological stressors, it may increase the risk of suicide.

Case Presentation: We report a case of a 49-year-old male, a non-smoker with no known comorbidities, suspected of committing suicide at his residence. The individual who was a businessman, had been experiencing significant financial difficulties. A strip of Zolpidem was found at the scene, with two tablets missing. The external and internal findings were consistent with CO poisoning, exhibiting the characteristic pink hypostasis and discolouration of mucous membranes and nail beds. Internally, the organs displayed pinkish hues typical of CO exposure, along with haemorrhagic changes in the gastric mucosa. Toxicological result was positive for Zolpidem with level of 0.04 micrograms per millilitre and carbon monoxide could not be analysed because of blood decomposition changes.

Conclusion: Autopsy and scene findings can support a diagnosis of carbon monoxide poisoning when toxicology results are delayed or limited. In this case, financial stress and possible suicidal ideation from long-term Zolpidem use may have contributed, highlighting the need for cautious prescribing and improved mental health awareness.

Key words: Charcoal burning, Suicide, Carbon monoxide poisoning, Zolpidem, Autopsy

Background

Charcoal burning as a method of suicide is increasingly prevalent in East and Southeast Asia, particularly in Malaysia, China, Hong Kong, Korea, and Taiwan. In Malaysia, it ranks as the third most common method of suicide, driven partly by cultural perceptions of it being a painless and peaceful death, often linked to beliefs in "rebirth" or a new life. This

Corresponding Author: Razuin Rahimi. Associate Professor at Department of Forensic Pathology, Faculty of Medicine, Universiti Teknologi MARA Sungai Buloh Campus, Malaysia, MD (USU Indonesia), Master of Pathology (Forensic Pathology) University of Malaya, Malaysia.

E-mail: dr_razuin@uitm.edu.my, razuin@gmail.com

Submission date: July 14, 2025 **Acceptance date:** August 19, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

method is most common among young adults aged 25–45 and individuals with psychiatric illnesses.[1]

Carbon monoxide (CO) poisoning occurs due to exposure to CO, a colourless, odourless gas released from sources such as defective appliances, industrial processes, vehicle exhaust, heating systems and charcoal burning.[2]It poses severe risks, especially to vulnerable populations, including children, the elderly, and individuals with anaemia or cardiovascular diseases. Fatal outcomes from CO poisoning depend on factors such as gas concentration, exposure duration, ambient temperature, physical activity, respiratory rate, and body position during exposure.[3]

Zolpidem, a non-benzodiazepine sedative-hypnotic medication used to treat insomnia, has been linked to increased risks of suicidal behaviour, even in individuals without a prior history of psychiatric illness.[4] Additionally, zolpidem can induce respiratory depression, which may compound the risks of fatal outcomes when combined with other factors such as carbon monoxide exposure.[5]Zolpidem is marketed under several brand names such as Zopim, Ambien, Stilnox and Edluar.[6]

Case Presentation

A 49-year-old male was found dead on the couch inside his enclosed room, with the doors and windows were locked from the inside.A burnt charcoal pot, a box of matches, and a lighter were discovered in the room. Additionally, a strip of medication labelled 'ZOPIM' was found, with two 10mg tablets missing. The deceased was a non-smoker, with no known medical illness. He was a businessman experiencing severe financial difficulties before his death. Based on the circumstantial evidence, the Investigating Police Officer concluded that the death was unnatural and attributed it to suicide.

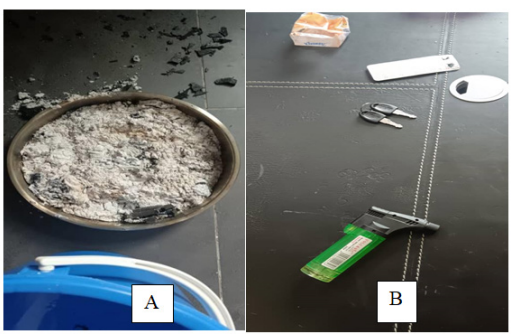




Fig.1 A. Burnt charcoal pot. B. Lighter was found near the couch where the body was located.

C. Box of matches nearby. D.10 mg strip of ZOPIM, with two tablets missing, was also found in the room.

Autopsy findings

Autopsy revealed a well-nourished adult male with no external injuries to the body. A cherry-pink hypostasis was observed at the posterior aspect of the body (Fig. 2A). Additionally, pinkish discolouration was noted on the nails, conjunctiva, and mucous membranes. During the dissection, a similar pinkish discolouration was observed in the soft tissues, heart, lungs, stomach and the smallintestine (Fig. 2B).

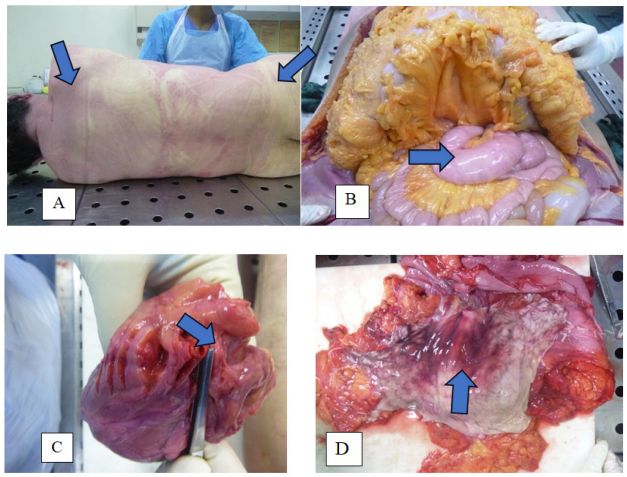


Fig. 2 A Cherry pink hypostasis at the back of the body (blue arrows). BPink hue was also observed in the internal organs, including the small intestine (blue arrow). C The anterior descending coronary artery shows an approximately 50% luminal occlusion by atheroma(blue arrow). D The cut-section of the body of the stomach shows haemorrhagic gastric mucosa(blue arrow).

Detailed examination of the thoracic and abdominal organs revealed no significant natural disease pathology which could have directly caused death at that point in time. Cut surfaces of the heart showed an approximately 50% luminal occlusion of the left anterior descending coronary artery by atherosclerotic plaques (Fig. 2C). There were no acute ischaemic changes or fibrosis of the myocardium seen macroscopically. The abdominopelvic organs were generally unremarkable, except for the stomach mucosa, which showed haemorrhagic changes (Fig. 2D).

Blood was collected for toxicological analysis prior to the body dissection, to confirm the presence of carbon monoxide and other substances, including Zolpidem. The toxicology report was positive for Zolpidem with a level of 0.04 micrograms per millilitre and carbon monoxide could not be analysed because of blood decomposition changes.

Histopathological findings

Representative tissue samples from the brain, heart, lungs, liver, spleens and kidneys were obtained for microscopic examination. Routine haematoxylin and eosin (H&E) staining showed significant pathological changes were discovered in the lungs and heart (Fig 3). Sections from the lungs revealed soot particles within the airways and destruction of the interstitium and alveoli associated with a pulmonary oedema (Fig. 3A & B). The heart exhibited patchy areas of dense collagen deposition, in keeping with ischaemic heart disease (Fig. 3C). The liver showed macro and microvesicular steatosis in keeping with fatty liver.Centrilobular sinusoidal congestion and dilatation was also observed, in keeping with acute ischaemic liver injury which was secondary to carbon monoxide poisoning (Fig. 3D). Microscopic examination of the brain, spleen and kidneys showed non-specific changes such as vascular congestion.

Fig. 4 A,B,C– Histopathological features of pulmonary oedema (blue star) in the lungs, soot within airways(blue arrow) and destruction of alveoli(blue cross). D - Dense collagen deposition in the myocardium of the left ventricle (blue cross), in keeping with ischaemic heart disease. E- Histopathological features of macro and microvesicular and steatosis (blue star), indicative of fatty liver, accompanied by centrilobular sinusoidal congestion and dilatation indicative of acute liver ischaemia (blue arrow).

In view of the circumstantial evidence and autopsy findings, the cause of death was concluded to be carbon monoxide poisoning. Incidental findings included microscopic myocardial fibrosis and fatty liver. Zolpidem was detected in the toxicological analysis, confirming that he had taken the medication prior to burning the charcoal. The myocardial fibrosis resulted from a previous cardiac ischaemic event due to luminal occlusion of the coronary artery.

Discussion

Several factors have been identified that may increase the risk of suicide, including psychiatric disorders, medical conditions such as chronic illnesses, and social factors such as relationship issues and financial difficulties. Interestingly, certain medications have also been associated with an increased risk of suicide as a side effect. These include psychiatric medications such as antipsychotics, neurological medications such as antiepileptics, opioid painkillers and hormonal contraceptives. Additionally, Zolpidem has also been linked to suicidal ideation as a potential side effect[4].In this case, the deceased was experiencing financial difficulties due to his unstable business. Toxicological analysis revealed the presence of Zolpidem at a concentration of 0.04 micrograms per millilitre, indicating that the medication had been taken prior to the incident. As the lethal level of Zolpidem is approximately 2 micrograms per millilitre, the detected amount was not sufficient to cause death on its own.[7]While the possibility of long-term use cannot be excluded, the presence of fatty liver is a pointer towards the long-term use of Zolpidem. We hypothesize that a combination of financial difficulties and long-term Zopim use contributed to his decision to take his own life.

Charcoal burning is the third most common method of suicide in Malaysia, after hanging and fall from height, according to a 10-year study Jamaldeen M.I., Hafiz W.M.et al.[8]Charcoal burning releases CO into the environment, which poses a significant risk of poisoning. Carbon monoxide has a 200–300 times greater affinity for haemoglobin than oxygen, forming carboxyhaemoglobin. When the saturation of carboxyhaemoglobin exceeds 30%, the characteristic cherry-pink colour becomes

evident in the body. In healthy adults under 60 years of age, death typically occurs when the blood carboxyhaemoglobin saturation exceeds 50-60%. However, individuals with pre-existing conditions, such as coronary artery disease or respiratory insufficiency, may succumb to fatal effects at lower CO concentrations due to impaired oxygen delivery and increased vulnerability to hypoxia[9]. In this case, the cherry-pink appearance indicated the presence of at least 30% carboxyhaemoglobin.

Zolpidem is known to cause side effects such as respiratory depression. In this case, the deceased also had 50% coronary artery occlusion. The combination of these factors may have worsened the hypoxic state induced by carbon monoxide exposure. The compromised coronary circulation could have further exacerbated the effects of carbon monoxide poisoning, potentially contributing to an earlier onset of fatality.

Conclusion

Autopsy and scene findings may support a diagnosis of carbon monoxide poisoning especially if laboratory analysis is delayed or hindered by decomposition changes of the postmortem specimens. In this case, pre-existing ischaemic heart disease and fatty liver could have lowered the threshold for fatality. Zolpidem, detected at sublethal levels, may have contributed through respiratory depression. As its long-term use is also associated with suicidal ideation,this case highlights the need for cautious prescribing of Zolpidem and improved public awareness of mental health support services.

Acknowledgements

I would like to thank all the staff members at Department of Forensic Medicine at Hospital Sungai Buloh, Malaysia.

Conflict of interest: None.

Funding: None.

Ethical Approval: We seek for waiver of ethical review and approval since the data were not directly indicative of the individual subject, observatory in nature and the research involved no risk to the deceased subject.

References

1. Pan Y, Loi M, Lan Y, Chen C, Cheng I. Perceptions towards charcoal burning suicide and the surge of this lethal method in Taiwan. Plos One. 2022. https://doi.org/10.1371/ journal. pone.0262384
2. Nouma Y. Carbon monoxide suicide by charcoal burning. A case report and review of literature. Pan African Medical Journal; 2021.https:// www.ajol.info/ index.php/ pamj/ article/ view/ 233460
3. Majdanik S, Banas B, Glowinski S, Borowiak K, An unusual case of suicide due to carbon moxide poisoning from a barbeque. Sciendo 2021.https:// doi:10.21164/pomjlifesci.756
4. Edinoff A, Wu N, Ghaffar Y, Prejean R. Zolpidem: efficacy and side effects for insomnia. Health psychology research2021.https:// doi:10.52965/001c.24927. PMID: 34746488; PMCID: PMC8567759.
5. Bouchette D, Akhondi H, Patel P, Quick J. Zolpidem: National library of medicine: 2022. https:// www.ncbi.nlm.nih.gov/ books/ NBK442008
6. Pergolizzi J, Taylor R, Raffa R, Nalamachu F, Chopra M. Fast acting sublingual Zolpidem for middle of the night wakefulness. Hindawi publishing cooperation: Sleep disorders 2014.http://dx.doi.org/10.1155/2014/527109
7. Garnier R, Guerault E, Muzard D, Azoyan P. Acute Zolpidem poisoning: Analusis of 344 cases. Journal of Toxicology 2008.https://doi.org/10.3109/15563659409011040
8. Jamaldeen M, Hafiz W, Shatnawi R, Shafee M, Nor F. A 10-year sociodemographic study of suicidal cases. Malaysian Journal of Pathology 2024. https:// mjpath.org.my/ 2024/ v46n2/ suicide-cases.pdf
9. Saukko P, Knight B, Knight's Forensic Pathology: 4th Edition 2016.

Review Article

DOI: https://doi.org/10.37506/bv2d4f64

Forensic Investigations in Cases of Human Rights Violations: Humanitarian and Legal Procedure

Danijela Bubanja-Petrović[1], Mirjana Tanić Slavić[2], Miroslav B. Milošević [3]

[1] MD, Health Center "Dr. Nika Labović" Berane, Montenegro, [2]MD, Health Center Kosovska Mitrovica, Serbia, [3]Assistant, Faculty of Medicine, University of Priština, with temporary seat in Kosovska Mitrovica.

How to cite this article: Danijela Bubanja-Petrović, Mirjana Tanić Slavić, Miroslav B. Milošević. Forensic Investigations in Cases of Human Rights Violations: Humanitarian and Legal Procedure. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

The aim of this paper is to explore the procedures and basic principles of forensic investigations related to mass murders and extrajudicial executions, including forensic medicine and anthropology, as well as the importance of exhumations in the context of human rights violations. Forensic work in these cases is crucial for training young professionals and strengthening justice and transparency in the investigative process. Investigations of mass graves and crimes concern not only the former Yugoslavia but also global examples, including cases in South America, Iraq, and Ukraine. This paper focuses on specific stages of the investigation: preliminary investigation, archaeological excavation, and identification of remains. The investigation must be carefully organized, with adequate protection for witnesses and investigators. Forensic experts must be trained and prepared to deal with the ethical and legal dilemmas that may arise during these complex processes. It concludes that, despite different geopolitical contexts, minimum standards for exhumation must be respected, and the families of missing persons should be provided with accurate information in accordance with human rights.

Keywords: mass murders, mass graves, forensic medicine, exhumation, human rights

Introduction

Forensic investigation, particularly in the context of mass killings and extrajudicial executions, is a critical aspect of investigating war crimes and human rights violations. These investigations serve a dual purpose: to provide justice to the victims and their families, and to identify those responsible for the crimes, thereby contributing to the process of peace and justice in post-conflict societies. Forensic investigations, including forensic medicine and anthropology, play a key role in these processes, offering objective evidence that is crucial for both legal and humanitarian outcomes.

This paper will discuss the fundamental principles of conducting forensic investigations, as well as the specifics related to the exhumation and examination of human remains. It will also address the challenges that arise during these investigations and emphasize the importance of cooperation between experts from various fields. In this context, the paper will examine

Corresponding Author: Danijela Bubanja-Petrović, MD, Health Center "Dr. Nika Labović" Berane, Montenegro.

E-mail: drdanijelabubanjapetrovic@gmail.com

Submission date: April 17, 2025 **Acceptance date:** May 18, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

examples of international forensic investigations and the role of local and international authorities in ensuring the safety and justice of victims.

Forensic Investigations in Mass Murders

Forensic investigations into mass killings during war and armed conflicts should not be limited to the former Yugoslavia. A key example of an international forensic investigation is the investigation into the Katyn Forest massacre during World War II, when Soviet forces executed a large number of captured Polish army officers.[1,2] After the end of World War II and during the Cold War, international forensic investigations were nearly nonexistent until the 1980s. During this time, a number of organizations emerged, such as the Argentine Forensic Anthropology Team (EAAF) in South American countries, and in the USA under the auspices of Physicians for Human Rights (PHR) and the American Academy for the Advancement of Science (AAAS).[3]

These and numerous other forensic teams have conducted dozens of international investigations, including exhumations, in regions such as the former Yugoslavia, Croatia, Bosnia and Herzegovina, Kosovo, Iraq, and more recently in Ukraine.[1,4,5]

Criminal and/or humanitarian investigations commonly begin in one of the following situations:[6,7]

After the murders have been committed, when it is necessary to send a specialized team to a specific area to carry out an investigation (collecting testimonies, talking to relatives of victims, scouting burial sites, etc.). During this period, it is possible that access to certain areas may be dangerous for team members. Additionally, if the country where the incident occurred has a functioning justice system and forensic experts, an investigation may already be underway in that area.

When a mass grave or a site of hidden burial (disposition of mortal remains) is accidentally discovered, most often in the post-conflict period, and the presumed incident that led to the deaths occurred relatively long ago.

When a Truth (and Reconciliation) Commission or investigative and judicial bodies initiate an investigation, usually after the establishment of new authorities following the end of the conflict.

Finally, much less frequently, the families of missing persons themselves initiate the exhumation without the help of authorities or the support of experts.

In any of the above situations, forensic medicine specialists, anthropologists, and archaeologists assist with exhumations and the examination of remains. This ensures the adequate collection of objective evidence in the investigation process, which, among other things, contributes to the realization of the right of families of missing persons to find out, that is, to receive appropriate information about their missing relatives.[8]

However, very often such incidents occur in underdeveloped countries and remote areas, which makes forensic investigations extremely difficult. Therefore, there is no single approach to these investigations (for example, the areas of the former Yugoslavia and the Democratic Republic of Congo or Rwanda), but each investigation needs to be defined in accordance with the specific circumstances and context.

Nevertheless, it is essential to adhere to certain minimum standards when exhuming and examining human remains. Ideally, archaeologists should be engaged for the exhumation. In other cases, when the excavation of human remains is assisted by, for example, firefighters, police officers, or volunteers, there is a risk that certain evidence will be destroyed, or that its collection and preservation will be missed. In such situations, when archaeologists are unavailable, it is necessary to provide those carrying out the excavation with basic information about the process and working methods.[9,10]

It is much more dangerous to leave the examination of exhumed remains to insufficiently trained, and especially unqualified, individuals. Therefore, the general recommendation is not to perform exhumations or, if possible, to preserve the bodies until appropriate experts are available.

Considering the psychological, legal, political, economic, and humanitarian aspects of exhumations, the identification of human remains, if possible, is an indispensable starting point for any investigation. What may, at first glance, appear to be a purely scientific and technical undertaking can often take

on ambiguous dimensions, frequently involving unexpected ethical dilemmas. It is therefore essential to raise these issues with the authorities (local or international) conducting the exhumation process before it even begins.[11]

In many situations, especially when United Nations missions request investigations, it is not clear from the outset whether the process will be part of a judicial investigation in accordance with criminal law, or whether it is simply a humanitarian operation to exhume remains. It is also important to remember that if exhumations are carried out in a territory under the mandate and activities of international organizations, local authorities and investigative bodies should always be involved, especially if these cases are to be prosecuted before domestic courts. It is essential that the UN mission takes these issues into account before sending a team of forensic experts to a particular area. Additionally, it is necessary to define other vital aspects of the investigation, such as securing evidence and ensuring its continuity, controlling the areas where the remains are buried, and determining whose jurisdiction the remains fall under after exhumation.[8,12]

It is not always the case that the goals of the investigation align with the expectations and wishes of the families of missing persons. Therefore, it is very important to understand the wishes of the families of missing persons, and it is unacceptable to support unrealistic expectations, especially regarding the possibility of identifying all exhumed remains, or that all responsible individuals will be identified and brought to justice.

It is also important to remember that sometimes it is not possible to fully apply all phases of conventional criminal investigations in contexts where human rights violations have occurred, and that certain cultural and religious specificities often need to be taken into account.

Stages in the investigation

Every investigation necessarily consists of the following three phases: [7,9,10,11]

1. Preliminary investigation: Interviews with witnesses, family members of missing persons, government officials, etc. The aim is to collect and analyze any available documents related to the specific event being investigated. It is also crucial to understand the relevant local context (e.g., ethnic, religious, and political relations in the community) and the dynamics of the conflict itself. A database is usually created at this stage to facilitate later verification of the data and to develop certain hypotheses about the case.
2. Archaeological investigation: This phase includes a visit to the possible burial site of the remains, interviews with witnesses to the burial, the actual excavation of the remains and other associated evidence, and the preparation of appropriate documentation.
3. Immediate examination of exhumed remains and necessary laboratory analysis to determine the cause of death and make an identification.

It is important that the individual phases take place in the specified order, namely, before the excavation itself, appropriate assumptions for identification must be made, because remains cannot be identified if relevant information is missing. This is sometimes, even very obviously, not sufficiently addressed by the authorities ordering the exhumation.[13,14]

Before a team of forensic experts is sent to the field, these three aspects need to be clearly defined, especially with regard to the following:

Time: Carrying out a preliminary or detailed forensic investigation requires time and good organization. Therefore, it is not advisable to send forensic experts to the field for only a few days, as such results will not be satisfactory.

Security: The safety of witnesses, the investigation team, and the excavation site itself must be ensured. In situations where investigations are carried out at the request of the UN, peacekeepers provide security for the participants and the site. It is not uncommon (especially when investigations are carried out in remote regions) that, after the conclusion of investigations and the withdrawal of security, families and witnesses—especially those who have provided assistance to the investigation—are subjected to pressure and intimidation by perpetrators, who are often nearby.[15,16]

Logistics: Before the forensic team begins its work, certain issues must be resolved, such as transportation to the excavation site, means of communication, provision of water, accommodation for team members, as well as the conditions under which the exhumed remains will be examined and stored before and after the examination. Additionally, it is necessary to ensure appropriate conditions for the storage of evidence collected during the investigation.[15]

In order to achieve the best possible results and save time and resources, it is always advisable to send a preliminary forensic mission to gain insight into the situation on the ground. During the duration of this mission, usually over a period of two to three weeks, the following activities will take place: [17,18]

- Meeting with team members, collecting all available reports and documents about the event under investigation, and making logistical and security preparations in order to visit the site and determine the goals or tasks of the investigation.
- A visit to the area where the investigation will be conducted, during which interviews will be conducted with family members of the missing persons in order to collect the data necessary for the identification of the remains. It is essential to interview the people who directly carried out the burial, visit the burial site itself, and create a map-sketch of the site. Test trenches (probes) should be opened at the site to check whether there are any remains. Additionally, the necessary equipment for the upcoming work should be determined.
- Contact local experts to determine if they can participate in the investigation, verify their level of expertise and training, and make arrangements for future training, if needed.
- Preparation of a report on the current situation and recommendations for future action.

Once all of this is done, the authorities must determine whether a detailed forensic investigation is necessary to properly exhume and examine the remains, with as little damage as possible.[19]

Therefore, a preliminary forensic mission can only provide a small amount of data that can corroborate or refute the data collected through testimony. For example, if, according to witnesses, 500 people were killed in one incident, the preliminary forensic investigation will determine whether there are burial sites. One or two graves will be opened to check whether they contain remains, whether the people were buried in civilian or military clothing, and based on this, the age and gender of the victims, injuries, etc. At this stage, this is sufficient, since later, during a detailed forensic investigation, the graves will be fully opened, and the remains will be examined and analyzed, which will take considerably more time and be done in a more exact manner.[20,21]

It is important to remember that a detailed forensic mission is a complex operation that also includes appropriate elements of logic. This phase will depend largely on the condition of the remains.

For example:

A) Recent murders: most bodies do not yet show pronounced cadaveric changes, soft tissues are still present, and it is necessary to have an appropriate autopsy room with refrigerators for storing the remains.

B) Older cases: the bodies are completely skeletonized, so there are no particular risks.

To illustrate, for example, to exhume a mass grave containing 20 people killed about a month before burial (i.e., bodies with preserved soft tissues), a six-member expert team would need at least ten working days. Forensic investigation does not only involve exhuming and counting bodies. Forensic or forensic investigations of mass graves are complex operations carried out as part of or for the purposes of a legal investigation into an event that resulted in the death of a large number of people in the context of armed conflict or internal violence.

In addition, forensic investigations constitute a significant element in the process of identifying human remains. In practice, even in the work of international teams, there are known cases in which the legal aspect of the investigation was given priority over the humanitarian aspect, which significantly affected the process of identifying remains and clarifying the fate of missing persons in connection with armed

conflicts and situations of internal violence. By acting in this way, forensic experts, or rather, primarily the organizers and leaders of expert teams, fail to make adequate efforts to ensure that the families of the missing receive timely and appropriate information about the fate of their missing members.[22]

It is important to remember that the International Committee of the Red Cross promoted the concept of the "right" of families to know the fate of their missing members as early as 2003. In addition to bringing to justice those responsible for the deaths of people in armed conflicts and situations of internal violence, this is also an important aspect of the approach to investigations.

Mapping

Open-source investigations and the mapping of their findings are regularly used in the context of human rights as a means of protection and monitoring justice.[23] Mapping projects (such as the Atlas of Environmental Justice[24]) or the Bitter Lands mass grave mapping project[25] often aim to address pressing societal challenges. Increasingly, principles and guidelines for good provenance and human rights governance are being developed in the context of other digital documentation efforts.[3,26]

Additionally, the question of the validity of open-source mapping, where content is publicly available, may not apply in all contexts. This question is particularly pertinent in the context of mass graves, as they can be vulnerable crime scenes. For example, in ongoing criminal investigations, it becomes clear that it is best to keep the locations of such sites secret to avoid exposure, protect families of the missing, and prevent witnesses from being subjected to assault, abuse, or harassment.

Case Studies: Forensic Science in the Service of Justice in Eastern Europe

The application of forensic science in investigating mass killings and human rights violations has become a crucial tool in post-conflict societies across Eastern Europe. The following two cases illustrate how forensic methods have contributed to victim identification, fact-finding, and the pursuit of justice.

The Vukovar Case, Croatia (1991)

One of the most well-known examples is the mass grave discovered at Ovčara, near Vukovar, where over 200 prisoners of war and civilians were executed following the fall of the city in November 1991. After the war, in cooperation with the International Criminal Tribunal for the former Yugoslavia (ICTY), an extensive exhumation and forensic investigation was conducted. Forensic teams applied methods of forensic anthropology, ballistics, and DNA profiling to identify the victims and establish causes of death. This evidence proved crucial in the prosecution of those responsible and represents one of the earliest instances of the systematic use of forensic science in international criminal justice.[27,28,29]

The Kosovo Case (1999 and aftermath)

Following the armed conflict in Kosovo (1998–1999), numerous mass graves, primarily of civilian victims, were uncovered. The International Commission on Missing Persons (ICMP), in collaboration with UNMIK and other organizations, launched a major effort to exhume and identify the remains. Forensic experts conducted large-scale DNA analyses, enabling the successful matching of human remains with the families of the missing. In addition to individual identification, these forensic investigations played a vital role in collecting evidence for legal proceedings and documenting patterns of international humanitarian law violations. Thus, forensic science served not only as a tool for justice but also for remembrance and reconciliation within the affected communities.[30,31,32]

These cases demonstrate how theoretical and methodological frameworks of forensic science can be applied in practice, particularly in the context of transitional justice. They also highlight the importance of interdisciplinary cooperation among legal experts, anthropologists, biologists, and international institutions in establishing truth and accountability.

Conclusion

Forensic investigation of mass murders and human rights violations is a key aspect in the process of uncovering the truth and securing justice for victims and their families. Exhumations and the analysis

of human remains must be carefully organized, adhering to the highest professional and ethical standards to ensure the accuracy and reliability of the collected evidence. Moreover, such investigative actions often require a multidisciplinary approach involving forensic medical experts, anthropologists, archaeologists, legal professionals, and cooperation with both local authorities and international organizations. During the exhumation process, it is essential to consider not only the legal aspects but also the humanitarian ones, including the families' right to learn the fate of their loved ones. Focusing the investigation on the protection of human rights and ensuring timely and reliable information about the fate of the missing is a necessary step toward a responsible and just investigative process.

Conflict of interest: None

Source of funding: None

Ethical clearance: Not applicable as it is a systematic review without the involvement of human or animal subjects.

References

1. Bass WM. Human Osteology. 3rd ed. Columbia: Missouri Archaeological Society; 1987.
2. Camps FE. Legal Medicine. London: Baillière Tindall; 1980.
3. American Association for the Advancement of Science (AAAS). Location-based data in crisis situations: Principles and guidelines. 2019. Available at: https://www.aaas.org/sites/default/files/2019-04/VGI%20Principles%20and%20Guidelines_FINAL.pdf
4. Stover E, Haglund WD, Samuels M. Exhumation of mass graves in Iraq: considerations for forensic investigations, humanitarian needs, and the demands of justice. JAMA. 2003;290(5):663–666. doi:10.1001/jama.290.5.663
5. Eliopoulos C. Human rights violations in Ukraine: the need for forensic investigations. Lancet. 2023;402(10404):772–773. doi:10.1016/S0140-6736(23)01959-1
6. Gordon I, Shapiro HA. Forensic Medicine: A Guide to Principles. Edinburgh: Churchill Livingstone; 1975.
7. Gorkić S. Medical Criminology. Belgrade: Ekonomska štampa; 1981.
8. Jokanović D, Mičić S, Pandurović S, Dožić V. The social character of forensic medicine in relation to responsibility for the protection of life and health. Srpski arhiv za celokupno lekarstvo. 1978;106(9):827–832.
9. Menez LL. The place of a forensic archaeologist at a crime scene involving a buried body. Forensic Sci Int. 2005;152(2–3):311–315. doi:10.1016/j.forsciint.2005.03.018
10. Virchow R. Forensic Medical Examination of the Dead (translation). Zagreb; 1919.
11. Milovanović M. Forensic Medicine. Belgrade–Zagreb: Naučna knjiga; 1965.
12. Pejaković S, Lukić M. Forensic Medicine. Belgrade: Poslovno-finansijski vodič; 1975.
13. Sauer NJ. Forensic Anthropology and Human Rights: Mass Graves and War Crimes Investigations. Springer; 2020. doi:10.1007/978-3-030-25951-8
14. Lukić D, et al. Forensic science in mass grave investigations: principles and practices. Int J Legal Med. 2021;135:1369–1381. doi:10.1007/s00414-021-02597-y
15. López G, et al. Security and logistical aspects of forensic investigations in post-conflict zones. Forensic Sci Rev. 2022;34(2):115–128.
16. United Nations Office on Drugs and Crime (UNODC). UN Guidelines on Forensic Investigations of Mass Graves in Post-conflict Regions. Vienna: UN; 2019.
17. Nino S. Challenges in exhuming mass graves in conflict areas: a review of methods and technologies. J Forensic Sci. 2021;66(5):1845–1853. doi:10.1111/1556-4029.14773
18. Fitzgerald L, Gardner B. Post-conflict forensic investigations: ethics, security, and the role of international organizations. Hum Rights Q. 2023;45(2):355–379. doi:10.1353/hrq.2023.0020
19. Harris L. International Law and Forensic Investigations of War Crimes. Cambridge: Cambridge University Press; 2019. doi:10.1017/9781108563312
20. Kostić J. The role of forensic investigations in the process of reconciliation in post-conflict societies. Eur J Forensic Sci. 2020;7(2):24–31.
21. Leclerc D, et al. Forensic evidence in mass graves: ethical issues and practical solutions. Legal Med. 2022;56:102049. doi:10.1016/j.legalmed.2022.102049
22. Harrison D. The importance of family rights in the context of missing persons and war crimes investigations. Int Hum Rights Law J. 2021;9(1):55–70.
23. Martinez-Alier J. Mapping ecological distribution conflicts: the EJAtlas. Extract Ind Soc. 2021;8(2):1–16. doi:10.1016/j.exis.2020.12.003

24. EJAtlas. Our mission. 2023. Available at: https://ejatlas.org/backoffice/cms/en/our-mission/
25. BIRN/Balkan Insight. Bitter Lands: Mass Grave Mapping Project. 2020. Available at: https://massgravesmap.balkaninsight.com
26. Dubberley S, Ivens G. Outlining a human-rights based approach to digital open-source investigations: A guide for human rights organizations and open-source researchers. Human Rights, Big Data and Technology Project. University of Essex; 2022.
27. International Criminal Tribunal for the former Yugoslavia (ICTY). Prosecutor v. Mrkšić, Radić, and Šljivančanin – Judgement (Case No. IT-95-13/1). The Hague: ICTY; 2007. Available at: https://www.icty.org/en/case/mrksic
28. Stover E, Peress G. The Graves: Srebrenica and Vukovar. Zurich: Scalo Publishers; 1998.
29. Wagner S. To Know Where He Lies: DNA Technology and the Search for Srebrenica's Missing. Berkeley: University of California Press; 2008. doi:10.1525/9780520942528
30. International Commission on Missing Persons (ICMP). Kosovo Case Work. Available at: https://www.icmp.int/where-we-work/europe/kosovo/
31. United Nations Interim Administration Mission in Kosovo (UNMIK). Report on forensic investigations in Kosovo: 1999–2000. 2001. Available at: https://reliefweb.int/report/kosovo/unmik-report-forensic-investigations-kosovo-1999-2000
32. Human Rights Watch. Under Orders: War Crimes in Kosovo. New York: HRW; 2001. Available at: https://www.hrw.org/report/2001/10/26/under-orders-war-crimes-kosovo.

Review Article

DOI: https://doi.org/10.37506/3aebx685

Forensic Entomology Cases Documented from Various Regions of India: A Comprehensive Review

Shazed Fatima[1], Madhu Bala[2]

[1]Research Scholar, [2]Assistant Processor, Department of Zoology and Environmental Sciences, Punjabi University, Patiala, Punjab, India.

How to cite this article: Shazed Fatima, Madhu Bala. Forensic Entomology Cases Documented from Various Regions of India: A Comprehensive Review. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

The examination of insect species inhabiting decaying cadavers often yields critical forensic insights, particularly regarding the determination of the postmortem interval (PMI), or the time of death. The life cycle of an insect operates akin to a precise chronometer; it commences its relentless ticking mere minutes or hours following demise. The intricacies of insect life cycles profoundly influence the calculation of postmortem intervals, even in instances where alternative methodologies are recognized for providing pertinent information. The present findings illuminate the distinctive characteristics of the local insect fauna associated with human corpses in various regions of India, as well as their ecological dynamics. Specimens of entomofauna were meticulously collected during autopsy procedures from the deceased. This paper discusses ten case studies spanning from historical to contemporary contexts within India. Among the subjects, whose ages ranged from a few months to 52 years, six were male and four were female. Both suicide and homicide constituted the causes of death. The primary objectives of this study were to gather data concerning the potential application of necrophagous insects in criminal investigations and to identify the specific insect species colonizing human remains.

Keywords: Forensic Investigation, Autopsy Findings, Medico-Legal Examination, Forensic insects, Necrophagus insects.

Introduction

In the field of medico-legal studies, forensic entomology—the application of insects and other arthropods in forensic investigations—is becoming more and more well-known internationally. While the main applications of insects have been in measuring the period of postmortem or time occurred since death, they have also been employed in drug validation[1], antemortem trauma determination, and cadaver shifting verification[1,2,3,4]. Two fundamental procedures must to be followed when using insects to calculate the least amount of time since death. The initial step is to accurately collect and identify the necrophagus insects, both at the site of death and also during the course of the autopsy. The following step is to employ the knowledge of the lifespan of the insect fauna to calculate the age of the collected

Corresponding Author: Madhu Bala, Assistant Processor, Department of Zoology and Environmental Sciences, Punjabi University, Patiala, Punjab, India.

E-mail: madhubaladhakane@gmail.com

Submission date: May 13, 2025 **Acceptance date:** July 21, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

insect specimens[5,6]. Cases of forensic entomology have been well documented in a number of global locations. Examples of this can be found for North America by Lord[7], for United States by Greenberg and Wells[8] and for Canada by Anderson[9]. Cases have been reported in Europe by Introna *et al.*[6], for Italy Turchetto *et al.*[10], for Norway Starkeby[11], for Germany by Benecke[12] (1998), Amendt *et al.*[13] (2000), Benecke and Lessig [14](2001), Schroeder *et al.* [15](2003) and Klotzbach *et al.*[16](2004), and for Spain by Arnaldos *et al.*[17] (2005). A number of cases that were documented have been reported from Colombia, which includes those by Barreto *et al.*[18] (2002), for Malaysia by Lee *et al.*[19](2004) and for Thailand by Sukontason *et al.*[20] (2001). Individual cases of insect-infested cadavers from the various parts of India have been reported by Kulshrestha and Satpathy[21] (2001), Babu *et al.*[22] (2013), Sharma *et al.*[23,24](2016, 2018), Babu *et al.*[25](2022).

Even though individual reports of such cases are helpful in this field but a unified study of such cases from a particular area of the world can offer additional insight regarding the circumstances surrounding them and the type of entomological evidence that takes place. Numerous reports of forensic entomology cases have already been reported from various parts of India; however, no study has compiled them all. In order to give a more detailed overview of the kinds of forensic entomology cases that take place in India, this study evaluates and discusses approximately ten instances from different regions of the nation to provide a clearer understanding of the patterns and characteristics of forensic entomological evidence in the country.

Case studies

Case 1

On May 28, 1998, an 18-year-old girl's corpse was discovered in a forest area in Bhopal. The skeletal remains were sent to Medicolegal institute Bhopal, India on June 16, 1998. It was found during the investigation that the mandible, skull, and other bones were all of human origin and displayed traits associated with the female sex. The skull had been injured, most likely by a sharp or hard item. Homicide was thus found to be the cause of death. Two families of adult Coleoptera, pupae and larvae of *Dermestes maculatus* (Dermestidae) (Figure 1: a) and two adults of the red-legged ham beetle *Necrobia rufipes* (Cleridae) (Figure 1: b) were represented by the entomological evidence retrieved from the remains[21].

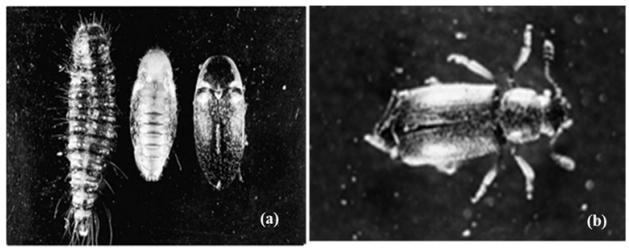


Figure 1: (a) Larvae, pupa and adult of *Dermestes maculatus* (Dermistidae). (b) Red legged ham beetle *Necrobia rufipes* (Cleridae)[21].

Case 2

On July 7, 2012 a nine-month-old headless male foetus's body was discovered in the State Forest Department's nursery in Jagdalpur, Chhattisgarh State, India. On July 8, 2012, an autopsy was conducted; the reason for death is still unknown. The corpse had already begun to decompose which was in advance decay stage (Figure 2: a). The blowfly *Chrysomya rufifacies*(Macquart) second instar larvae were discovered to be infested in the chest and belly area (Figure 2: b). There were no adult flies on or around the body[22].



Figure 2: (a) Headless male foetus's body in advance decay stage. (b) Larvae of *Chrysomya rufifacies*[22].

Case 3

On October 26, 2014, a 23-year-old woman's body was found in the rice field in the hamlet of Kakrala, in the District of Patiala, Punjab, India. The body was in dry decay stage of decomposition (Figure 3: a). The thumbs and fingers on both hands were absent. All thoracic and abdominal organs were absent, as was the lower portion of the chest cavity and the entire abdomen. Lower portion of spinal column was exposed. There were no soft tissues in the skull. Pupae of *Chrysomya rufifacies* and *Chrysomya*

megacephala were gathered from ripped garments. From the clothing and skull of the deceased, adult flies of the species *Chrysomya megacephala* and *Chrysomya rufifacies* as well as beetles belonging to the family Dermestidae (*Dermestes maculatus*), were also collected[26].



Figure 3: (a) Woman body in rice field in dry decay stage[26].

Case 4

On March 30, 2015, a 40-year-old man's body was found in a residential neighbourhood in the district of Ludhiana, Punjab, India, at the swollen stage of decomposition (Figure 4: a). The deceased's body was discoloured, his facial characters were almost unrecognisable, and his genitals had been hacked off (Figure 4: b), causing them to entirely degrade. Upon forensic inspection, two incisions were discovered: one measuring 8 by 1 cm on the left side of the neck and another measuring 15 by 12 cm between the legs. The cause of death was determined to be multiple stabbing murder. Maggots and pupae of *Chrysomya megacephala* were among the entomofauna discovered on the body (Figure 4: c) [24].

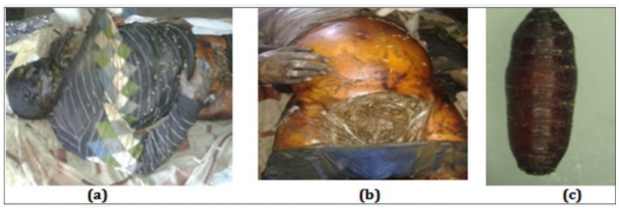


Figure 4: (a) Corpse of a male person in bloated stage of decomposition. (b) Mutilated body. (c) pupae of *Chrysomya megacephala*[24].

Case 5

On April 5, 2015, a 45-year-old man's body was discovered at his resident in Ludhiana, Punjab and it was in an advanced state of decomposition. Head injuries were the cause of death. The remnants showed signs of extremely inflated, blackening, and partial skin thinning on the limbs, fingers, and legs. The tongue protrusion helped to partially identify facial features (Figure 5: a). There were nibbling scars on both feet. A 5-by-1/2-cm cut was located in the centre of the forehead (Figure 5: b). The surrounding area was bloated, discoloured, and reddish brown. On the outside middle of the left thigh, there was an oblique incised cut measuring 16 by 1/2 cm that was discoloured crimson (Figure 5: c). *Chrysomya megacephala* larvae (second instar) were crawling all over the body (Figure 5: d) [23].



Figure 5: (a) Corpse showing protruding tongue. (b) Head injury. (c) Wound on Left thigh. (d) Larvae crawling over the body of corpse[23].

Case 6

On April 22, 2015, a partially petrified body of a 26-year-old man was discovered from his residence in Patiala, Punjab. Body was in the stage of livor mortis (Figure 6: b). At this stage, blood develops as a purplish-red marking on the skin, resembling a bruise, and it can reveal the body's position at the moment of death. Neck and upper chest regions were partially skeletonized as the underneath bones were entirely visible. The right side of the face, head, neck, and upper chest were devoid of soft tissue, including skin, making it impossible to identify the features of the face. Reason of death was unclear.

The entomofauna discovered on the body includes various *Chrysomya rufifacies* larval instars (Figure 6: a) as well as beetles from Dermestidae and Cleridae family such as *Dermestes maculatus* (Figure 6: c) and *Necrobia rufipes* (Figure 6: d) respectively[24].

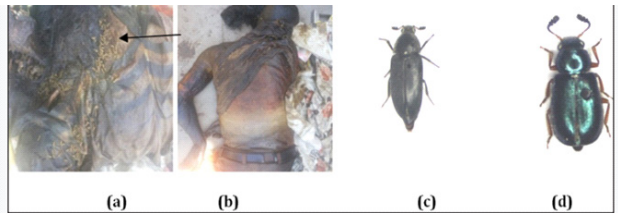


Figure 6: (a) Abundance of larvae of C. *rufifacies* on chest region. (b) Backside of the corpse shows Livor mortis. (c) *Dermestes maculatus*. (d) *Necrobia rufipes*[24].

Case 7

On April 22, 2015, the corpse of a 52 years old woman, was found in the Bhakra Canal in Patiala, Punjab. The body had partially distinguishable facial features and was in a bloating state of decomposition (Figure 7: a and b). The body was releasing an unpleasant odour. The postmortem examination revealed that muddy water was found in the stomach, trachea, and larynx, indicating that the entire body was inflated with water. There have been reports of skin peeling on the limbs and abdomen. Cause of death drowning. The entire body contained *Chrysomya megacephala* adults and egg batches (Figure 7: c and d). It has been reported that beetles from the Histeridae family were found on dead bodies (Figure 7: e) [24].

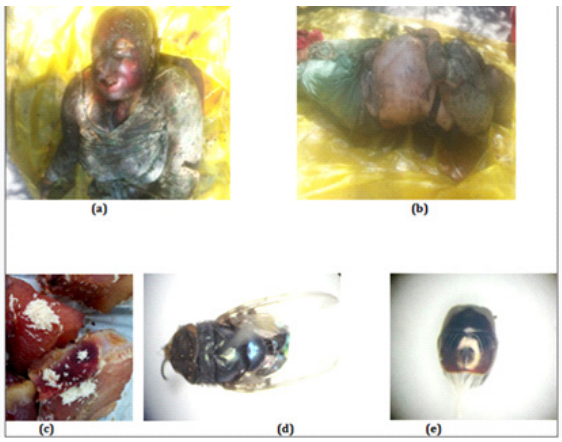
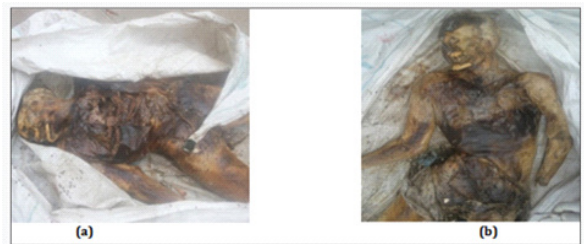


Figure 7: (a and b) Drowned female dead body. (c) Cluster of eggs belonging to blow flies. (d) *Chrysomya megacephala* (e) Histerid beetle found on the dead body[24].

Case 8

On July 6, 2015, a 32-year-old unidentified man was found decomposing in the drain of Dholanwala Bridge in Bhatthalan, Punjab (India) (Figure 8: a and b). Fractured sternum and multiple fractured ribs on each side with blood infiltration was revealed in autopsy; cause of death was chest injury led by multiple rib fractures. The body contained insect fauna, including Dipteran flies *Chrysomya megacephala*, *Chrysomya rufifacies* and maggots of *Chrysomya albiceps* as well as an unidentified wasp[24].



Case 9

On July 5, 2015, a male body estimated to be 50 years old was found in a paddy field near Pathanmajra, Punjab (Figure 9: a and b). Body fluids were leaking out of the inflated, decomposing body. The skin was flaking, discoloured, and reeked. The cause of death remained a mystery. Numerous*Chrysomya albiceps* larval instars (Figure 9: c) coated the body[24].



Figure 9: (a and b) Maggots infestation all over the male dead body. (c) III instar of *Chrysomya albiceps*[24].

Case 10

On June 15, 2018, an unidentified 45-year-old man's skeletonized body was discovered beneath a culvert on the Bijapur-Bhopalpatnam Road in Chhattisgarh. The body was far into its advanced state of disintegration (Figure 10: a & b). A skeletonized face with patches of adhering muscle and skin remained in place (Figure 10: a). There was also no rigour mortis or postmortem lividity. The body was a dark brown colour, with maggots scattered around

the face, chest, upper limbs, abdominal region, and perineum. Numerous *Chrysomya megacephala* larval instars coated the body[25].

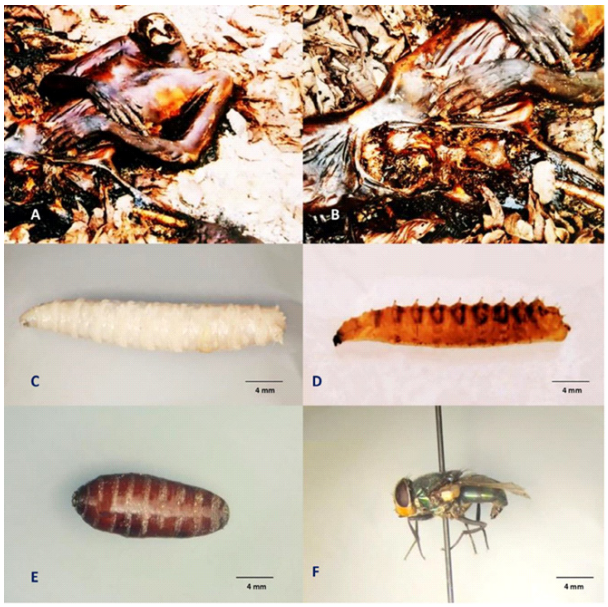


Figure 10: (A & B) Skeletonized remain of male corpse. (C) Third instar larvae of C. *megacephala*. (D) Third instar larvae of *C. rufifacies*. (E) Pupa of *C. megacephala*. (F) Adult of *C. megacephala* collected from corpse[25].

Conclusions

In these case studies, the preponderance of forensic specimens employed to ascertain the minimum post-mortem interval (PMImin) predominantly comprised *Chrysomya spp*. (Diptera) larvae in their second and third instars. This observation is consistent with findings reported by Lee[27] and Affandy et al.[28]. Typically, third instar maggots are encountered during the active decay phase of decomposition, a stage characterized by an overpowering odor that readily alerts individuals in proximity to its presence. The utilization of coleopteran species is notably infrequent, particularly in instances where corpses have undergone mummification. During the initial decomposition phase, dipterans—especially *Chrysomya spp.*—are generally the first group of flies to be identified. Previous research has extensively documented the pivotal role of *Chrysomya spp*. as significant decomposers[27,29]. From the beetle family, *Dermestes maculatus* De Geer, 1774 is predominantly employed for PMImin estimation in cases where only skeletal remains are recovered. In scenarios occurring within enclosed structures, an additional day is factored into the specimen's estimated age when calculating PMImin, as it may necessitate several hours for flies to infiltrate a confined space. This report delineates all ten instances. Among the corpses, two of the most prevalent species are *C. megacephala* and *C. rufifacies*. A comprehensive compilation of various insect species engaged in resolving forensic case studies to determine PMI(min) in India is presented herein.Table 1. In certain case studies, we have not acquired any information regarding PMI estimation.

Table 1: List of forensically significant insect species implicated in postmortem interval (PMI) estimation.

Case no.	Species collected	Estimated PMI
1	*Dermestes maculatus* De Geer, 1774 *Necrobia rufipe*s (Fabricius, 1781)	-
2	*Chrysomya rufifacies*(Macquart, 1842)	3.5 days
3	*Chrysomya megacephala* (Fabricius 1794) *Chrysomya rufifacies* (Macquart, 1842) *Dermestes maculatus* De Geer, 1774	9.6 days
4	*Chrysomya megacephala* (Fabricius 1794)	-
5	*Chrysomya megacephala* (Fabricius 1794)	4.5 days
6	*Chrysomya rufifacies* (Macquart, 1842) *Dermestes maculatus*De Geer, 1774 *Necrobia rufipes* (Fabricius, 1781)	-
7	*Chrysomya megacephala* (Fabricius 1794) Histerid beetle	-

Continue.....

8	*Chrysomya albiceps* (Wiedemann, 1819) *Chrysomya megacephala* (Fabricius 1794) *Chrysomya rufifacies* (Macquart, 1842)	-
9	*Chrysomya albiceps* (Wiedemann, 1819)	-
10	*Chrysomya megacephala* (Fabricius 1794)	4.8 days

Acknowledgements

We sincerely thank the Department of Zoology and Environmental Sciences, Punjabi University, Patiala, India, for granting access to laboratory facilities. We also gratefully acknowledge the financial assistance provided by the Council of Scientific and Industrial Research (CSIR), New Delhi, under the file number 09/140(0183)/2021-EMR-1.

Author Contributions: MB- designed the study, analysed the data, SF- literature review, wrote the manuscript.

Declarations

Conflict of interest: The authors declare that they have no conflict of interest.

Source of funding: Nil

References

1. Catts EP, Goff ML. Forensic entomology in criminal investigations. Annu Rev Entomol. 1992; 37:253–272.
2. Smith KGA Manual of forensic entomology, 1986; pp (1- 205).
3. Hall RD, Huntington TE. Medicocriminal entomology. Entomology and death: a procedural guide. Joyce's Print Shop, Clemson, SC, 1990, 1-8.
4. Benecke M. Forensic entomology: arthropods and corpses. In: Tsokos M (ed) Forensic pathology review. Humana, Totowa, NJ, 2004; pp 207–240.
5. Erzincllioğlu YZ. The application of entomology to forensic medicine. MedSci Law.1983; 23(1): 57-63.
6. Introna Jr F, Campobasso CP, Di Fazio A. Three case studies in forensic entomology from southern Italy. J Forensic Sci.1998; 43(1): 210-214.
7. Lord WD. Case histories of the use of insects in investigations. Entomology and death: a procedural guide. Joyce's Print Shop, Clemson, SC, 1990; pp 9-37.
8. Greenberg B,Wells JD. Forensic use of *Megaselia abdita* and *M. scalaris* (Phoridae: Diptera): case studies, development rates, and egg structure. J MedEntomol.1998; 35(3): 205-209.
9. Anderson GS. The use of insects to determine time of decapitation: a case-study from British Columbia. J Forensic Sci.1997; 42 :947–950.
10. Turchetto M, Lafisca S, Costantini G. Postmortem interval (PMI) determined by study sarcophagous biocenoses: three cases from the province of Venice (Italy). Forensic SciInt. 2001; 120(1-2): 28-31.
11. Stærkeby M. Dead larvae of *Cynomya mortuorum* (L.) (Diptera, Calliphoridae) as indicators of the post-mortem interval—a case history from Norway. Forensic Sci Int. 2001; 120(1-2): 77-78.
12. Benecke M. Six forensic entomology cases: description and commentary. J Forensic Sci. 1998; 43:797–805.
13. Amendt J, Krettek R, Niess C, Zehner R, Bratzke H. Forensic entomology in Germany. Forensic Sci Int. 2000; 113(1-3): 309-314.
14. Benecke M, Lessig R. Child neglect and forensic entomology. Forensic Sci Int. 2001; 120:155–159.
15. Schroeder H, Klotzbach H, Püschel K. Insects' colonization of human corpses in warm and cold season. Legal med. 2003; 5: S372-S374.
16. Klotzbach H, Krettek R, Bratzke H, Püschel K, Zehner R, Amendt J. The history of forensic entomology in German-speaking countries. Forensic Sci Int. 2004; 144(2-3): 259-263.
17. Arnaldos MI, Garcia MD, Romera E, Presa JJ, Luna A. Estimation of postmortem interval in real cases based on experimentally obtained entomological evidence. Forensic Sci Int. 2005; 149 :57–65.
18. Barreto M, Burbano, ME, Barreto P. Flies (Calliphoridae, Muscidae) and beetles (Silphidae) from human cadavers in Cali, Colombia. Mem InstOswaldo Cruz. 2002; 97:137–138.
19. Lee HL, Krishnasamy M, Abdullah AG, Jeffery J. Review of forensically important entomological specimens in the period of 1972-2002. Trop Biomed. 2004; 21(2): 69-75.
20. Sukontason K, Sukontason K, Vichairat K, Piangjai S, Lertthamnongtham S, Vogtsberger RC, Olson JK. The first documented forensic entomology case in Thailand. J Med Entomology, 2001; 38(5): 746-748.

21. Kulshrestha P, Satpathy DK. (2001). Use of beetles in forensic entomology. Forensic SciInt. 2001; 120(1-2): 15-17.

22. Babu BS, Dharma H, Bharti M,Colony B. Estimation of post mortem interval by rearing *Chrysomya rufifacies* (Macquart, 1842) (Diptera: Calliphoridae): A case study from central India. Anil Aggrawal J Forensic Med Toxicol. 2013; 14: 1-11.

23. Sharma A, Bala M. Case study and PMI estimation of male corpse from Ludhiana, Punjab, India: An implication of ADH method. Indian JForensic MedToxicol. 2016; 10(2): 28-33.

24. Sharma A, Bala M and Singh N. Five case studies associated with forensically important entomofauna recovered from human corpses from Punjab. JFSCI. 2018; 7: 001-006.

25. Babu BS, Kumar R, El-Sharnouby M, Salah M, Sayed S, Alhazmi A, Hemeg HA, Basheeruddin SM, Asdaq M and Bala M. Calliphorids as forensic indicator to facilitate PMI estimation: a case study from Chhattisgarh, India. J King Saud UnivSci. 2022; 34 (1): 101709.

26. Bala M, Sharma A. Postmortem interval estimation of mummified body using accumulated degree hours (ADH) method: a case study from Punjab (India). J FSCI. 2016; 1:1-5.

27. Lee HL. Recovery of forensically important entomological specimens from human cadavers in Malaysia. Malaysia JPathol. 1989; 11: 33-36.

28. Afandy H, Omar B, Marwi MA, Ahmad MS, Halim M, Feng SS, Moktar N. A review of forensic specimens sent to Forensic Entomology Laboratory Universiti Kebangsaan Malaysia for the year 2001. Trop Biomed. 2003; 20 (1): 27-31.

29. Omar B, Marwi MA, Mansar AH, Rahman MS, Oothuman P. Maggot of *Synthesiomyia nudiseta* (Wulp) (Diptera: Muscidae) as decomposer of corpses found indoor in Malaysia. TropBiomed. 1994b; 11: 145-148.

Original Article

DOI: https://doi.org/10.37506/denf0f38

A Retrospective Study on Snake Bite Fatalities at a Tertiary Care Hospital in Visakhapatnam (2021 -2023)

Gummadi Venugopal Rao[1], Mopuri Venkateswarlu[2], Srinivasa Rao Vavilapalli[3], Devaraj Boddepalli[4], Hari Krishna Chowdary Lingampalli[5], Mamatha K[6], Kattamreddy Ananth Rupesh[7]

[1]Associate Professorof Forensic Medicine and Toxicology, Government Medical College, Sangareddy, Telangana State, [2]Associate Professorof Forensic Medicine and Toxicology, ACSRGovernment MedicalCollege, Nellore, Andhra Pradesh, [3]Assistant Professor of Pathology, Andhra Medical College, Visakhapatnam, Andhra Pradesh, [4]Resident, Department of Forensic Medicine and Toxicology, Visakhapatnam, Andhra Pradesh, [5]Resident, Department of Forensic Medicine and Toxicology, Visakhapatnam, Andhra Pradesh, [6]Professor and Head, Department of Forensic Medicine and Toxicology, Visakhapatnam, Andhra Pradesh, [7]Assistant Professor of Forensic Medicine, Andhra Medical College, Visakhapatnam, Andhra Pradesh.

How to cite this article: Gummadi Venugopal Rao, Mopuri Venkateswarlu, Srinivasa Rao Vavilapalli. A Retrospective Study on Snake Bite Fatalities at a Tertiary Care Hospital in Visakhapatnam (2021-2023). Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Snake bite remains a significant clinical toxicology concern in India, particularly in rural areas where access to medical care is limited, delays in treatment are common, and faith healing is often sought. This study analyses the epidemiology of snakebite fatalities at King George Hospital, Visakhapatnam (2021–2023), focusing on sociodemographic patterns, geographical distribution, seasonal trends, and venom toxicity types. All cases with a confirmed history of snakebite were included. Results indicate a higher prevalence among middle-aged male farmers, with the monsoon season posing the highest risk. The lower limb was the most common bite site in farmers, with a marginal occupational association ($p = 0.080179$). However, the time of bite showed no significant correlation with venom toxicity type ($p = 0.214918$). Public education on venomous snake identification, first-aid measures, and prompt antivenom administration are essential to reducing fatalities. Vulnerable populations, particularly agricultural workers, must exercise keen caution during the monsoon season and adopt protective measures such as wearing appropriate clothing and footwear.

Keywords: Snake bite, Envenomation, Autopsy, Anti Snake Venom, Chrono-fatality.

Introduction

Snake-bite fatalities remain a significant public health concern across various regions globally. The wide range of geographical landscapes and diverse habitat in India are responsible for the high incidence of snake-bite cases apart from agrarian snake-human

Corresponding Author: Gummadi Venugopal Rao, Associate Professor of Forensic Medicine and Toxicology, Government Medical College, Sangareddy, Telangana State.

E-mail: venugopalgummadi99325@gmail.com

Submission date: February 22, 2025 **Acceptance date:** March 24, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

encounters. Of the approximately 3,000 snake species recognized globally, only about 15% are venomous and have the potential to cause fatalities in humans through their bites[1].The Elapidae and Viperidae families comprise two major groups of venomous snakes responsible for most of the snakebite fatalities[2]. India harbours more than 60 species of venomous snakes. Among these, four highly venomous species, the common cobra (Naja naja), Russell's viper (Daboia russelii), common krait (Bungarus caeruleus), and saw-scaled viper (Echis carinatus), are extensively distributed across the region. These species are collectively and conventionally designated as the "Big Four"[3].

Snakebite fatalities in India constitute nearly half of all snakebite-related deaths worldwide annually. Between 2000 and 2019, India recorded an estimated 1.2 million snakebite deaths, equating to an average of approximately 58,000 deaths per year[4].Individuals residing in rural households, particularly those near farms, as well as those engaged in agricultural and related activities, are more susceptible to snake encounters. This heightened exposure increases the likelihood of snakebites, resulting in significant mortality and morbidity within these populations[2].

This present study aims to analyse the epidemiology of snakebite fatalities at King George Hospital, Visakhapatnam (2021–2023), focusing on sociodemographic patterns, geographical distribution, seasonal trends, and venom toxicity types.

Materials and Methods

All cases with a history of snakebite, either clinically confirmed or eye witnessed, were included, while other cases were excluded. The study analysed autopsy findings of snakebite fatalities conducted between 2021 and 2023 at the Department of Forensic Medicine, Andhra Medical College, King George Hospital, Visakhapatnam. Data were collected from medical records, death summaries, inquest reports and autopsy records, tabulated in Microsoft Excel, and analysed. The Institutional Ethics Committee approved the study.

Results

This study included a total of 30 snakebite fatality cases, comprising 21 males (70%) and 9 females (30%). The age distribution of cases is detailed in Table 1. Regarding locality, 86.67% of the victims were from rural areas, while 13.33% were from urban areas (Table 2). In terms of occupation, 60% were farmers, 26.67% were students, and 13.33% belonged to other professions. Based on snake venom toxicity, 50% of cases were attributed to neurotoxic bites, 40% to hemotoxic bites, and 10% to unknown toxicity (Table 3).

Concerning the time of envenomation, 33.33% of victims were bitten during the daytime (6 AM to 6 PM), while 66.67% were bitten at night (6 PM to 6 AM). Seasonal distribution showed that 10% of cases occurred in winter, 23.33% in summer, and 66.67% during the rainy season (Table 4). The lower limb was the most commonly affected body part (63.33%), followed by the upper limb (23.33%) and other regions (13.34%) (Table 5).

Survival analysis revealed that 26.66% of victims succumbed within 6 hours, 13.33% between 6 to 12 hours, 10% within 24 hours, 13.33% within 48 hours, and 36.67% survived for more than 2 days after envenomation (Table 6).

Table 1: Age Distribution of Snake Bite Death Cases

Age	No. of victims		Percentage
	Males	Females	
0-10	3	0	10%
11-20	3	2	16.67%
21-30	1	0	3.33%
31-40	6	3	30%
41-50	2	1	10%
51-60	1	2	10%
>60	5	1	20%
	21 (70%)	**9** (30%)	100%

Table 2: Distribution of Locality of Victims

Locality	No. of victims	Percentage
Rural	26	86.67%
Urban	4	13.33%

Table 3: Type of Toxicity of Snake

Toxicity	No. Of victims	Percentage
Neurotoxic	15	50%
Hemotoxic	12	40%
Unknown	3	10%

Table 4: Seasonal Distribution of Snake Bites

Seasons	No. of victims		Percentage
	Day	Night	
Winter (Nov to Feb)	1	2	10%
Summer (March to June)	2	5	23.33%
Rainy (July to Oct)	7	13	66.67%
	10 (33.3%)	**20** (66.7%)	100%

Table 5: Part of the Body Involved

Body part	No. of victims	Percentage
Upper limb (arm/ forearm/wrist/hand)	7	23.33%
Lower limb (ankle/ foot)	19	63.33%
Other	4	13.34%

Table 6: Period of Survival Between Snake Bite and Death

Period of survival	No. of victims	Percentage
0-6 hours	8	26.67%
6-12 hours	4	13.33%
12-24 hours	3	10%
24-48 hours	4	13.33%
> 2 days	11	36.67%

In farmers, the lower limb was the most common bite site, showing a marginal association with occupation (p-value = **0.080179**). In contrast, the association between the time of the bite and the type of snake venom toxicity was not statistically significant (p-value = **0.214918**).

Discussion

In the present study, out of 30 cases, 21 (70%) were males, and 9 (30%) were females, indicating that males are more commonly the victims of snakebites. This can be attributed to the fact that in India, males predominantly engage in outdoor work, increasing their risk of accidental exposure to snakebites compared to females. The findings of this study are consistent with those reported by Kumar et al.[5], V. Rajashekar et al.[6], Katta Sri Ram et al.[7], and Mohapatra et al.[8]

The most commonly affected age group was 31–40 years (30%), followed by >60 years (20%). These values are consistent with the findings of Katta Sri Ram et al. and Vinay J et al[9]but are discordant with those of Kumar et al. and V. Rajashekar et al.

In the current study, 86.67% of the victims were from rural areas, while 13.33% were from urban areas. This highlights the increased incidence of snakebites in rural areas along with the limited availability of facilities for early treatment. Similar findings were reported by V. Rajashekar et al. and Rakhi Dandona et al.[10], where the majority of patients also belonged to rural areas.

In the current study, 60% of the victims were farmers, aligning with findings from comparative literature. This emphasises the higher risk of snakebites among individuals working in agricultural fields, as these areas serve as natural snake habitats. The highest number of snakebite-related deaths occurred during the monsoon season (66.67%), followed by summer (23.33%) and winter (10%). The increased incidence in the monsoon season is likely due to heightened agricultural activity. These findings are consistent with those of V. Rajashekar et al., and Vinay J et al.

In the study population, 36.67% of victims survived for more than 2 days, while 26.66% succumbed within 6 hours, and 13.33% survived between 6 to 12 hours after the bite. These findings contrast with the studies by V. Rajashekar et al. and Katta Sri Ram et al., where most victims succumbed within 6 to 24 hours.

In the current study, snakebites occurred most frequently on the lower extremities (63.33%), followed by the upper extremities (23.33%) and other body parts (13.34%). These findings align with comparative literature, as snakes are ground-dwelling, and the legs are the most accessible. Activities like walking barefoot, farming, and moving through vegetation increase exposure, with bites often occurring defensively when snakes are stepped on or disturbed, particularly in rural areas during nights.

In the current study of 30 victims, 50% were bitten by neurotoxic snakes (cobras and kraits), 40% by hemotoxic snakes (vipers), and 10% by unidentified species. The same has been deduced from the clinical

phenotype before death. These findings align with V. Rajashekar et al. and Katta Sri Ram et al. but differ from Peranantham et al.[11] and Vinay J et al. Additionally, 66.67% of bites occurred between 6:00 PM and 6:00 AM (night), consistent with Peranantham et al. but contrasting with Katta Sri Ram et al., who reported more cases between 6:00 AM and 6:00 PM (day).

India's "Big Four" venomous snakes exhibit distinct activity patterns influencing bite risks. The Indian Cobra (*Naja naja*) and Russell's Viper (*Daboia russelii*) are primarily diurnal and crepuscular but may also show nocturnal activity in warm conditions. In contrast, the Common Krait (*Bungarus caeruleus*) is strictly nocturnal, often biting people in their sleep, while the Saw-scaled Viper (*Echis carinatus*) is also mainly nocturnal but may bask during early mornings or late evenings. Studying the associations between venom toxicity type and bite timing has limitations since envenomation syndromes overlap. A more accurate approach is utilisingspecies-specific bite timing to understand chronofatality. However, species identification is a challenging task in most of the cases[12].

Cobras and kraits bite defensively, with cobras displaying their hood as a warning, while vipers, particularly saw-scaled vipers, are highly aggressive and strike quickly when provoked. Kraits, being less aggressive, tend to avoid confrontation; however, their nocturnal activity increases accidental encounters, often occurring during sleep when individuals unknowingly roll over them. In contrast, cobras are more active during the day and transition hours like the dawn and dusk[12].

The distribution of these snakes is influenced by prey availability, with rodents, lizards, and amphibians forming a major part of their diet. As a result, they are commonly found in agricultural fields, wetlands, grasslands, backyards, gardens near human settlements, and abandoned areas[12].

Snake activity is also seasonally influenced. During winter hibernation, they remain largely inactive, sheltering in burrows, leading to fewer human encounters and snakebite incidents. However, as temperatures rise, snakes emerge to regain energy, seek food, and prepare for breeding, resulting in increased activity and a rise in snakebite cases. The breeding season further heightens human encounters, particularly for kraits and Russell's vipers, whose breeding coincides with the monsoon season. Additionally, increased agricultural activity, prey abundance, lack of shelter, and the search for warm places during the rainy season contribute to a peak in snakebite incidents. These trends align with the findings of the present study[12].

Confirming snakebite as the cause of death can be difficult without clear physical evidence like fang marks or local toxicity manifestations, but Radioimmunoassay (RIA) offers a highly sensitive method for detecting venom antigens. By using radioactively labelled antibodies that bind to venom components, RIA can accurately quantify venom even in low concentrations, making it useful in postmortem investigations and clinical diagnoses. However, its use is limited by the need for specialized equipment, radioactive materials, and trained personnel, as well as challenges like cross-reactivity and venom metabolism. Despite these limitations, RIA remains an important tool in confirming envenomation and guiding treatment.

Snakebite fatalities are a persistent public health challenge in India, disproportionately affecting rural populations, particularly male agricultural workers. Previous studies have established an increased incidence of snakebites during the monsoon season. Moreover, frequent lower limb involvement in bites has been well documented in the literature, with prior studies indicating mortality within 24 hours of envenomation. Most fatal cases are attributed to bites from the "Big Four" venomous snakes—cobra, krait, Russell's viper, and saw-scaled viper—with night-time bites, particularly from kraits, posing a significant risk due to their nocturnal behaviour and tendency to bite victims while asleep.

This study provides new insights into the epidemiology of snakebite fatalities in the Visakhapatnam region, identifying a marginal occupational association(p-value = **0.080179)** between farming and lower limb bites, and observing a greater proportion of victims surviving beyond 48 hours compared to previous studies. This finding highlights the need to investigate factors influencing fatality during this period, such as the time taken to seek medical care, and the availability of antivenom (ASV)

in peripheral centers. Furthermore, the present study adds to the growing body of evidence on snakebite fatalities occurring predominantly between 6 AM and 6 PM(66.67%), suggesting that dawn and dusk are particularly high-risk periods for snake-human encounters, also aligns with the nocturnal behavior of certain venomous species. Visibility conditions and the use of protective measures by farmers are important variables to consider when interpreting these findings. To the best of our knowledge, this is the first study of its kind in the Visakhapatnam region.

Although the present study focused on the mortality aspect of snakebites, examining associations between occupation, timing of bites, and venom toxicity, it is important to acknowledge the significant progress made in reducing mortality through increased access to antivenom in India[13]. The major limitations of the present study include the limited sample size, and the unknown species of the snakes involved in the bites (we categorised them in to type of toxicity based on clinical picture from medical records).

Future studies should explore the morbidity associated with snakebites, as well as conduct spatiotemporal analyses[14] to identify clusters of incidents. Additionally, further research is needed to understand snake behaviour and human-snake encounters in a holistic manner, aiming to prevent snakebites while preserving the reptiles' right to live and contribute to biodiversity, thus enhancing the planet's overall health. A collaborative approach involving herpetologists, agricultural scientists, local municipalities, and panchayat bodies—utilizing AI and technology-based tracking systems—could offer innovative solutions to reduce harmful snake-human encounters, benefiting both human populations and wildlife conservation. It is essential to foster a safety culture among vulnerable agricultural populations through behavioural changes to reduce snakebite risk.

Conclusion

This study highlights the higher prevalence of snakebites among middle-aged male farmers working in agricultural fields during the monsoon season. Implementing protective and preventive measures can significantly reduce snakebite fatalities. These measures include exercising caution in snake-prone areas, wearing proper foot wear and protective clothing, avoiding bushy backyards, staying vigilant by carefully checking surroundings, and maintaining a clean household environment to deter snakes from seeking food and shelter. Public education on identifying venomous snakes, providing first aid for bites, and the importance of seeking antivenom rather than relying on faith healing is crucial. Additionally, offering psychological support to snakebite victims post-encounter plays a vital role in their recovery. Studies on the economic impact of human-snake encounters are essential to persuade policymakers to invest in snakebite prevention and fatality reduction.

Conflict of interest: None to declare.

Financial support: Nil.

Ethics committee approval: Approved by the Institutional Ethics Committee of Andhra Medical College vide S.No:/IEC AMC/2025 application dated 29/12/2024.

References

1. Gold BS, Dart RC, Barish RA. Bites of venomous snakes. N Engl J Med [Internet]. 2002;347(5):347–56. Available from: http://dx.doi.org/10.1056/NEJMra013477
2. Gajbhiye RK, Munshi H, Bawaskar HS. National programme for prevention & control of snakebite in India: Key challenges & recommendations: Key challenges & recommendations. Indian J Med Res [Internet]. 2023;157(4):271–5. Available from: http://dx.doi.org/10.4103/ijmr.ijmr_2424_22
3. Chakma JK, Menon JC, Dhaliwal RS, Indian Council of Medical Research#. White paper on venomous snakebite in India. Indian J Med Res [Internet]. 2020;152(6):568–74. Available from: http://dx.doi.org/10.4103/ijmr.IJMR_3377_20
4. Suraweera W, Warrell D, Whitaker R, Menon G, Rodrigues R, Fu SH, et al. Trends in snakebite deaths in India from 2000 to 2019 in a nationally representative mortality study. Elife [Internet]. 2020;9. Available from: http://dx.doi.org/10.7554/eLife.54076
5. Kumar M, Babu P, Kumar S, Subrahmanyam BV, Rammohan P, Srinivas M, et al. A retrospective review of snake bite victims admitted in a tertiary level teaching institute. Ann Afr Med [Internet]. 2014;13(2):76. Available from: http://dx.doi.org/10.4103/1596-3519.129879

6. V.Rajasekhar, Bandaru S, Ram KS, Mandala M, N.Sridhar Reddy. An autopsy based study of deaths due to snake bite in Kurnool region of Andhra Pradesh. Indian J Forensic Med Toxicol [Internet]. 2024;18(2):163–7. Available from: http://dx.doi.org/10.37506/s089x706

7. Ram KS, Y.K.C.Rangaiah, L. Ananda Kumar, Mandala M, Abhinay M, Khan MA, et al. Autopsy-based study of snakebite fatalities in Guntur region: A comprehensive two-year analysis. Indian J Forensic Med Toxicol [Internet]. 2023;17(4):66–70. Available from: http://dx.doi.org/10.37506/ijfmt.v17i4.19943

8. Mohapatra B, Warrell DA, Suraweera W, Bhatia P, Dhingra N, Jotkar RM, et al. Snakebite mortality in India: a nationally representative mortality survey. PLoSNegl Trop Dis [Internet]. 2011;5(4):e1018. Available from: http://dx.doi.org/10.1371/journal.pntd.0001018

9. Vinay J, M.G. Shivaramu, Vijay Kumar A.G., Kumar U. A profile of fatal snakebite cases in rural mandya: A retrospective study. Indian Journal of Forensic Medicine and Pathology [Internet]. 2018;11(4):245–50. Available from: http://dx.doi.org/10.21088/ijfmp.0974.3383.11418.4

10. Dandona R, Kumar GA, Kharyal A, George S, Akbar M, Dandona L. Mortality due to snakebite and other venomous animals in the Indian state of Bihar: Findings from a representative mortality study. PLoS One [Internet]. 2018;13(6):e0198900. Available from: http://dx.doi.org/10.1371/journal.pone.0198900

11. Peranantham S, Jeyasingh T An autopsy-based analysis of deaths due to snakebite envenomation. Journal of South India Medicolegal Association; 2018; 10(2) 70-4

12. Whitaker R, Captain A. *Snakes of India: The Field Guide*. 1st ed. Chennai: Draco Books; 2004.

13. Dhikav V, Gupta R, Saini J, Mandani P, Upadhyay P, Shakeel K, et al. Snakebites in three districts of rural areas of Western India during winter. Ind J Med Spec [Internet]. 2025;16(1):12–7. Available from: http://dx.doi.org/10.4103/injms.injms_57_24

14. Barhadiya G, Purkayastha J, Saha AK, Ghosh C. Spatial and temporal assessment of snake encounters in urban Delhi, India. Sci Rep [Internet]. 2024;14(1):5506. Available from: http://dx.doi.org/10.1038/s41598-023-50373-0.

Original Article

DOI: https://doi.org/10.37506/4hsfmj60

Evaluation of the Effectiveness of Peer Assisted Learning in Forensic Medicine & Toxicology for Third Phase MBBS Students

Iram Khan[1], Mohammad Shakeel[2], Rinki Kalra[3], Dilutpal Sharma[4], R. K. Dixit[5]

[1]Professor & Head, Department of Forensic Medicine & Toxicology, Hind Institute of Medical Sciences. Safedabad, Barabanki. U.P., [2]Professor & Head, Otorhinolaryngology & Head & Neck Surgery, Hind Institute of Medical Sciences, Mau. Ataria, Sitapur.U.P. India., [3]Assistant Professor, Department of Forensic Medicine & Toxicology, Hind Institute of Medical Sciences, Safedabad. Barabanki. U.P. India, [4]Additional Professor, Department of Biochemistry, King George's Medical University, Lucknow. U.P. India, [5]Professor, Pharmacology & Therapeutics, King George's Medical University, Lucknow. U.P. India.

How to cite this article: Iram Khan, Mohammad Shakeel, Rinki Kalra. Evaluation of the Effectiveness of Peer Assisted Learning in Forensic Medicine & Toxicology for Third Phase MBBS Students. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Background: With the introduction of Competency-Based Medical Education (CBME) by the National Medical Commission (NMC) in India, teaching methodologies that foster competencies like leadership, team building, and independent learning are essential. Peer-Assisted Learning (PAL), where peers help each other learn, is one such methodology.

Aim and objective: This study aimed to evaluate the effectiveness of PAL in enhancing the understanding of subjects and overall learning experience of undergraduate students. The objective was to compare the test scores of students taught by PAL with those taught by didactic lectures.

Materials and method: This comparative analytical study involved 100 third-phase part 1 MBBS students at Hind Institute of Medical Sciences, Barabanki, U.P., India, from October to December 2023. Fifty students each were assigned to Group A (didactic lectures) and Group P (PAL) using consecutive sampling. Student performance was assessed using paired t-tests within each group, and the efficacy of PAL was evaluated by comparing post-test scores using unpaired t-tests. Feedback was collected via a Google form to analyze learners' attitudes and views.

Results: There was consistent improvement in the post test scores of Group P; also there is significant improvement in the performance in test-3($p < .0006$). Majority of students found the sessions engaging and found them helpful.

Conclusion: PAL has shown positive impact on students learning outcome. It also promotes independent learning and team building in students. However, the results are influenced by factors such as phase of student, planning involved and quality of lesson plan.

Key Words: Peer Assisted Learning ,Comparative Study,Forensic Medicine & Toxicology Medical Education, Undergraduate Students.

Corresponding Author: Iram Khan, Professor & Head, Department of Forensic Medicine & Toxicology, Hind Institute of Medical Sciences, Safedabad, Barabanki. U.P.

E-mail: driramkhan101179@gmail.com

Submission date: March 27, 2025 **Acceptance date:** April 30, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

Introduction

Medical education in India is undergoing a significant transformation, shifting from traditional didactic methods to more interactive and collaborative models, such as Peer Assisted Learning (PAL). This shift is crucial for educators, leaders, and researchers in Graduate Medical Education (GME) as it aims to enhance the learning experience and academic performance of medical students.

Traditional lecture formats, though longstanding, are increasingly being scrutinized in favor of methods that promote active participation and collaboration. PAL has shown promise in enhancing knowledge reinforcement through support, experience exchange, and feedback.[1,2,3]Its use for various purposes like simulation learning and all round development is extensively being researched.[4,5] Despite its potential, there remains a lack of comprehensive studies examining PAL's effectiveness in Forensic Medicine especially in current scenario when Forensic Medicine has been made part of Third phase. There is an urgent need to explore use of PAL as team building and communication enhancing tool which can help student to make effective communication with patient and authorities in Medico-legal cases.

While some research indicates PAL as a valuable learning tool in the medical field, [6, 7, 8, 9] there are inconsistencies in findings. Specifically, a study by Mussrat U suggests that students in PAL groups may not perform as well as their peers in traditional learning environments.[10] This discrepancy highlights the need for more detailed investigations to understand the conditions under which PAL is most effective and to identify the specific benefits and limitations of this approach.

Most of the studies are done on 'near peers' and in this project we have studied the impact on 'same-year dyadic PAL,' where peers from the same academic year learn together.This project aims to compare the efficacy of Didactic Lectures (Group A) and Peer-Assisted Learning (Group P) sessions in enhancing the understanding and learning of various aspects of Forensic Medicine in undergraduate medical students. Furthermore, the long term effect of PAL as tool to help develop team building capacity in students has also been explored.

Methodology

This comparative analytical cross-sectional study was conducted at the Hind Institute of Medical Sciences (HIMS), Safedabad. The study involved third-phase part 1 MBBS students of Batch 2020-2021. A total of 100 students participated in the study, which took place from September to December 2023. A sample size was chosen to ensure sufficient statistical power. Power calculations were based on expected effect sizes from similar studies, and adjustments for multiple comparisons were made as necessary.

Two different teaching methods were employed and sessions were structured and followed a predefined syllabus focusing on core competencies in Forensic Medicine & Toxicology. Three topics i.e. 1. Mercury poisoning, 2. Organic Irritants, and 3. Toxicity associated with Iron, Copper, and Thallium from the core competencies of Forensic Medicine & Toxicology were chosen for the study.

1. **Group A (Control Group)**: This group consisted of 50 students who received traditional didactic lectures delivered by faculty members.
2. **Group P (Test Group)**: This group also comprised 50 students who participated in Peer-Assisted Learning (PAL). The students were divided into subgroups of 5, with each subgroup having a designated leader. These leaders were provided with teaching materials and guidelines to facilitate the learning process. The leaders coordinated and mentored their peers during the learning sessions. The session was conducted in laboratory to ensure that students are studying.

The sessions were conducted as following scheme

1. **Pretest**: At the start of each session, an MCQ-based pretest was administered to all students. The pretest consisted of ten questions specific to the topic being covered.
2. **Learning Session**: Both groups underwent a one-hour learning session using their respective teaching methods.
3. **Post-test**: After the learning session, a post-test with the same ten MCQs was administered.
4. **Repetition**: This process was repeated for all three topics over the study period.

Analysis of outcome

The primary outcome measured was the improvement in test scores from pretest to post-test for both groups and to further assess the efficacy of PAL, the Post Test Results of Group A, exposed to didactic lectures, and Group P, engaged in Peer Assisted Learning (PAL) were compared. Additionally, qualitative feedback from Group P (PAL group) was collected to assess students' perceptions of the PAL method.

The MCQ tests used in the pretest and post-test were designed by faculty members of the Department of Forensic Medicine & Toxicology and validated prior to the study. The feedback form used for qualitative data collection was also validated by the scientific committee.

The scores from the pretests and post-tests were recorded and entered into an Excel sheet. Paired T-tests were used to analyze the data, comparing pretest and post-test scores within each group. Independent T-tests were used to compare the post-test scores between Group A and Group P. Scores were expressed as mean ± standard deviation, and a p-value of <0.05 was considered statistically significant. Feedback from Group P was collected using a pre-designed Google Form, validated by the scientific committee. The Feedback Form included two open-ended questions and four closed-ended questions of which two were Likert scale questions and two were yes/no/maybe questions. Thematic analysis was conducted on the open-ended responses to gain insights into students' experiences with PAL.

The study was reviewed and approved by the Institutional Ethics Committee of Hind Institute of Medical Sciences, Barabanki, U.P. Ethical considerations included obtaining informed consent from all participants, ensuring confidentiality, and maintaining the voluntary nature of participation. Furthermore, the lectures for above mentioned topics were repeated for students after the completion of the study and classes were included as extra hours to benefit students in attendance.

Observation and Results

The paired t-test results for pre-test and post-test scores for Group A **(Table 1)** and Group P **(Table 2)** across three sessions indicate a significant improvement in student performance across all three tests.

When two methods were compared **(Table 3**), it was seen that in Test 1, Group A performed significantly better than Group P (p=0.003). In Test 2, there was no statistically significant difference between the two groups (p=0.431), indicating both methods were equally effective. However, In Test 3, Group P outperformed Group A significantly (p=0.0006).

Feedback was collected from Group P using a Google Form, with a response rate of 100% (50/50). 74% of students found PAL sessions engaging and felt comfortable during the sessions. Though, majority of students (60%) felt the sessions were beneficial for understanding the topic, 30% were undecided and 10% didn't find it helpful. 70% of students rated their satisfaction with PAL as 4 or 5 on a Likert scale. Also, 68% were in favour of more such sessions, while 32% did not. The PAL sessions had its share of challenges and benefits as mentioned by the students in response to open ended questions **(table 4 and table 5).**

Table 1: Paired t-test results for Pre-Test and Post-Test Scores for Group A (Didactic Teaching) across three sessions.

Group A	Pre-Test Mean Score	Post-Test Mean Score	t-Stat	p-Value
Test 1	2.92	6.02	-9.62	<0.000001
Test 2	5.22	8.04	-8.07	<0.000001
Test 3	4.52	7.10	-8.81	<0.000001

Table 2: Paired t-test results for Pre-Test and Post-Test Scores for Group P (PAL Session) across the same three sessions.

Group P	Pre-Test Mean score	Post-Test Mean Score	t-Stat	p-Value
Test 1	2.84	4.84	-5.92	<0.000001
Test 2	5.00	8.28	-9.77	<0.000001
Test 3	4.52	7.10	-8.81	<0.000001

Table 3: Analysis of Post-Test Scores of Group A and Group P using independent t-Test

Comparison	Group A Mean Score	Group P Mean Score	t-Stat	p-Value
Test 1	6.02	4.84	3.04	0.003
Test 2	8.04	8.28	-0.79	0.431
Test 3	7.10	8.28	-3.52	0.0006

Table 4: Benefits of PAL Sessions (appreciated by the students)

BENEFIT	PERCENTAGE
Collaborative Learning Enhances Topic Comprehension	62%
Time efficiency	20%
Identifying Areas of Improvement	8%
Liked everything about PAL	10%

Table 5: Difficulties faced by students

DIFFICULTY	PERCENTAGE
Dissatisfied with methodology	12%
Time constraints	12%
Lack of interaction/motivation	8%
Seating arrangements	2%
No difficulties reported	66%

Discussion

Peer assisted learning has been there since ages, however, how best to use it for various purposes is being extensively researched recently. The study was initiated with the aim of assessing the impact of Peer Assisted Learning (PAL) on the comprehension of Forensic Medicine & Toxicology and the overall learning experience for undergraduate students. The analysis revealed a notable improvement in learning, as indicated by the negative t-statistic value and a P value of less than 0.05 by third session. This underscores the efficacy of PAL and its potential to serve as an effective teaching strategy, particularly when implemented with thoughtful planning, structured facilitation, and contextual alignment.

The significant t-values (negative) and extremely low p-values on comparing both the groups indicate that our chosen teaching methods have significantly improved understanding of the given topics. The comparative analysis of two methods has revealed valuable insights into the effectiveness of peer assisted learning.

In Test 1, the positive t Statistic (3.0377) and p-value of 0.003 shows that didactic learning is better than PAL. It could be due to the reason that it was the first session and group dynamics might not have established as it was a new concept to students. Similar observation has also been made by Mussarat U on second-year dental students, where it was concluded that teacher-assisted learning yielded more favorable outcomes compared to PAL.[10] Non familiarity with learning methodology, phase of learner (second year) and choice of topic might have affected the outcome.

Session 2, suggests no statistically significant distinction between two methods. However, it can be attributed to improvement in performance of Group P participants, as can be shown by the marginally higher mean score.

In Test 3, Group P significantly outperformed Group A. By this stage, group dynamics had become well established, and students were more familiar and comfortable with their peers. This familiarity appeared to foster collaborative strategies aimed

at improving performance, such as focusing on key concepts, clarifying doubts within the group, and actively engaging in peer discussions. These proactive behaviors were noticeably less evident in the didactic teaching group. The study suggests that the effectiveness of Peer-Assisted Learning (PAL) increases as students build interpersonal rapport and collaborative comfort over time. This implies that PAL may be more effective when implemented later in the academic phase or after a period of structured group interaction. Introducing a preliminary orientation or demonstration session to develop group cohesion could enhance the overall success and impact of PAL-based teaching strategies.

A recent study by Chan et al. utilized a flipped classroom, same-level peer-assisted learning approach for clinical skills, yielding similar positive results to our observations.[12] Additionally, our results align with existing literature suggesting that PAL can enhance academic performance and serve as an effective method for teaching complex subjects, particularly when implemented with appropriate structure and support.[9, 13]

Our study also support the observation by other researchers that PAL session is effective for students in third and fourth year of their studies as by this time students have developed basic concept of the medicine and now are able to grasp simpler concept on their own and student interaction has also been established, forming a prerequisite for successful PAL implementation.[9]

Thematic analysis of the feedback reveals that about 74% of the students have found the sessions comfortable and graded it 4 and 5 on Likert scale. It may be attributed to the non-formal setup of PAL. 60% of the students have agreed that sessions have helped in enhancing their understanding of the subject and 30% were undecided. Only 10% of the students didn't find it helpful. It can be attributed to various advantages and disadvantages of PAL.

On analyzing the overall experience of the students with new methodology we found 70% of the students were satisfied with the method as they have put in their own effort for the learning. However, 30% of students expressed dissatisfaction with the PAL methodology and it could be due to the non proficiency of their peers in the subject.

A new insight from our findings is that the effectiveness of PAL appears to increase over time as students become more familiar with their peers and develop stronger group dynamics. This highlights the importance of allowing time for team bonding and considering implementation in later phases of the curriculum. Analysis of the difficulties faced by students was done to devise ways such sessions interesting and successful. Students have also quoted lack of interaction and motivation from their peers (8% students), seating arrangement (1 student) as some of the difficulties, indicating a potential need for more interactive elements in PAL sessions. Not only students but faculty also emphasized the importance of infrastructure and seating layout in the success of PAL. Future PAL implementations should account for physical setup to encourage interaction and mobility. Despite this, a significant majority (66%) reported no difficulties and found sessions beneficial, indicating overall satisfaction with PAL sessions.

When asked to elaborate on the advantages, 31 students (62%) mentioned collaborative learning in form of group discussions helped them in understanding the concepts better. Similar observation has been by other researchers also.2, 14 A few of the students has mentioned that peer explained the topic in simpler manner, since they studied topics more thoroughly, they will be able to retain it for a longer time.

Time management has provided some interesting reflections. It has been a challenge to some students (10%) as they found it difficult the cover the topic all by themselves within the given time. However, it has been an advantage to others (20%) as they found dividing the topic among themselves and teaching it to other a better way to cover larger topic within stipulated time. It highlights the importance of planning the learning activity in advance keeping all aspects of learning objectives in the activity and managing it effectively within time. This also reflects that the team dynamics play important role and PAL might be of help if used effectively.

The survey results indicate that 68% of students show a preference for additional PAL (Peer-Assisted Learning) sessions, suggesting an appreciation

for the novel learning method. However, 32% of students did not express a particular preference for extra sessions. Some students voiced concerns about feeling at a loss when not directly taught by a teacher. Similarly, Zang and Maconochie in their meta-analysis have also reported that Students engaged in peer-assisted learning express reservations about the proficiency and clinical expertise of peer tutors, particularly when faced with technically complex queries.[9] There is a perception that peer tutors may not match the pedagogical skills of professional teachers. Additionally, student attitudes may be influenced by the expectation of a conventional medical education, leading to negative perceptions when receiving instruction from fellow students.14 This highlights the importance of balancing innovative approaches with traditional teaching methods.

The findings of our study also suggest that the influence of faculty goes beyond the direct teaching-learning process, impacting the overall effectiveness of the educational approach. Other researchers have also emphasized that educational interventions are of multifaceted nature where both instructional methods and the context of supervision play interconnected roles.[14]

Unfamiliarity with PAL can increase student apprehension; conducting a demo session beforehand can make approach more effective as reflected in our study.

We agree with other researchers that a PAL session requires time management, robust lesson planning, specific logistical and structural improvement to enhance the efficacy of sessions[9,13] and it is not as easy as it seems .

Limitations

Potential biases in self-reported data and the lack of control over extraneous variables, which might affect internal validity. The specific educational context in India might limit external validity and generalizability to other regions or educational systems.

Future studies should explore the influence of different supervisory roles on the effectiveness of PAL and investigate long-term effects on academic performance.

Conclusion

In conclusion, PAL can serve not only as a supplementary teaching tool but also as a primary method for delivering selected topics. Incorporating PAL into medical curricula can enhance both cognitive and non-cognitive skills such as teamwork, leadership, and communication, aligning well with the goals of Competency-Based Medical Education (CBME). The findings underscore the choice of phase of learners, choice of topics, multifaceted nature of educational interventions, interconnected roles of instructional methods and supervision, in enhancing overall educational outcome. Additionally, PAL can be used as a teaching learning tool for easy topics for third phase MBBS students, for Small-Group Teachings and Self Directed Learning sessions in CBME (Competency Based Medical Education) curriculum and for revision classes.

Ethical Clearance taken from Institutional Human Ethics Committee and approval letter no is HIMS/IHEC/2023/Faculty/Dr.Iram Khan dated: 26/09/23.

Conflict of Interest: Nil

Source of Funding: Nil

References

1. Burgess A, Diggele CV, Roberts C, Mellis C. Planning peer assisted learning (PAL) activities in clinical schools. BMC Med Educ. 2020; 20 (Suppl 2):453.
2. Garkal K, Shete A, Somwanshi N. Learning by teaching: Role of "peer-assisted learning" in medical education. J Contemp Med Edu. 2019; 9(1): 17–20.
3. Vanagamudi A, Padmini PJ. Peerassisted learning: Our experience with undergraduate medical students. Arch Med Health Sci. 2021;9:361-3.
4. Snapp C, Bassett C, Baldwin A, Hill JR, DeBusk R. Peer-Assisted Learning in Undergraduate Medical Education for Resilience and Well-being. Med.Sci. Educ. 2023; 33: 5–6.
5. Jauregui J, Bright S, Strote J, Shandro J. A Novel Approach to Medical Student Peer-assisted Learning Through Case-based Simulations. West J Emerg Med. 2018 Jan;19(1):193-197.
6. Lockspeiser TM, O'Sullivan P, Teherani A, Muller J. Understanding the experience of being taught by peers: the value of social and cognitive congruence. Adv Health SciEduc Theory Pract. 2008;13(3):361–72.

7. Wadoodi A, Crosby JR. Twelve tips for peer-assisted learning: a classic concept revisited. Med Teach. 2002;24(3):241-244

8. Zhang Y and Maconochie m. A meta-analysis of peer-assisted learning on examination performance in clinical knowledge and skills education. BMC Medical Education. 2022; 22:147

9. Guraya SY, Abdalla ME. Determining the effectiveness of peer-assisted learning in medical education: A systematic review and meta-analysis. Journal of Taibah University Medical Sciences. 2020;15 (3):177-184

10. Mussarat U, Ehsan F, Zainub A, Saeed MHB, Hassan U, Jahan S. MEDICAL EDUCATION: Comparative Evaluation of Peer Assisted Learning and Teacher Assisted Learning Using Small Group Discussion. Vol. 17 No. 1 (2022): March. https://journals.riphah.edu.pk/ index.php/jiimc/article/view/1320.

11. Capstick, Stuart. (2004). Benefits and Shortcomings of Peer Assisted Learning (PAL) in Higher Education: an appraisal by students. Available from : https://www.researchgate.net/publication/268414551_Benefits_and_ Shortcomings_of_Peer_ Assisted_Learning_PAL_in_Higher_ Education_an_appraisal_by_students.

12. Chan E, Botelho MG, Wong GTC. A flipped classroom, same-level peer-assisted learning approach to clinical skill teaching for medical students. PLoS One. 2021 Oct 22;16(10). :e0258926. doi: 10.1371/journal.pone.0258926. PMID: 34679098; PMCID: PMC8535182..

13. Awasthi S, Yadav KK. Assessment of the acceptance and effectiveness of peer assisted learning in pediatrics. Int J App Basic Med Res 2015;5:S3-6.

14. Steele DJ, Medder JD, Turner P. A comparison of learning outcomes and attitudes in student- versus faculty-led problem-based learning: an experimental study. Med Educ. 2000; 34:23–29.

Original Article

DOI: https://doi.org/10.37506/ztj3qj77

A Study on Profile of Death due to Hanging in Jamnagar Region

Jitendra S. Rathod[1], Haresh J. Parmar[2], Chauham A. Desani[3], Kalpeshkumar R. Chaudhari[4]

[1]Associate Professor, Dept. of Forensic Medicine, Shri M P Shah Government Medical College, Jamnagar (Gujarat), [2]Senior Resident Doctor, Dept. of Forensic Medicine, Shri M P Shah Government Medical College, Jamnagar, [3]Assistant Professor, Dept. of Forensic Medicine, Shri M P Shah Government Medical College, Jamnagar, [4]Assistant Professor, Dept. of Forensic Medicine, Govt. Medical College, Surat.

How to cite this article: Jitendra S. Rathod, Haresh J. Parmar, Chauham A. Desani. A Study on Profile of Death due to Hanging in Jamnagar Region. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Death due to Hanging is the commonest unnatural death encountered by forensic experts. Hanging is the most common method of committing suicide and ending one's life. To know the burden of a suicide due to hanging in society, a retrospective study was conducted in Forensic Medicine and Toxicology Department, Shri M P Shah Government Medical College and Guru Gobind singh Government Hospital, Jamnagar. Total number of 224 cases of hanging was studied during the period of one year from the December-2023 to January-2023 in this study. The data like age, sex, religion, ligature material etc. was collected and analysed. According to this study, 224 people died due to hanging out of 1231 post-mortem performed in one year period time in the Forensic Medicine and Toxicology Department, Jamnagar. Male predominance was seen in this study which included 66.51% male,33.03% female and 1 case was from trans-gender. Maximum number of person died due to hanging was from the 21-30 years of age which is 41.52% of total cases. Total of 98.66% cases are in suicidal in nature in this study. Death due suicide is a major public health related issue in society. Death due the hanging is a partially preventable situation by proper education, guidance, counselling and seeking professional help early stage of stress.

Key Words: Hanging, Male Predominance, Ligature material, epidemiological parameters.

Introduction

Hanging is the form of asphyxia, which is caused by the suspension of the body by ligature which encircles the neck, the constriction force being the weight of the body. Deaths due to hanging are one of the most important unnatural deaths encountered by forensic experts during post-mortem examination. Hanging can be suicidal, accidental and homicidal. Most of the cases of hanging are suicidal in nature while accidental is uncommon and homicidal is rare. Hanging is the most common method adopted to commit suicide worldwide and in the India. As per NCRB (National Crime Reports Bureau) report 2022, Hanging cases are 57.0% in 2021 which is 93,580 in

Corresponding Author: Haresh J. Parmar, Senior Resident Doctor, Dept. of Forensic Medicine, Shri M P Shah Government Medical College, Jamnagar.

E-mail: phj8198055@gmail.com

Submission date: Jun 9, 2025 **Acceptance date:** July 17, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

number. While in 2022 hanging cases are 58.2% which is 99,415 of total suicide in India.

The key research gap in the hanging cases is the lack of following standard autopsy protocols, regarding the internal injuries and differentiating the ante mortem and post mortem artifacts, ligature material and knot analysis.

Many authors have found different types of incidence in different places in cases of hanging, this variation can be due to various factors affecting like age, sex, education, socio-economic status, mental status of particular person, influences of society, geographical influences etc.

Aims and objectives

This Retrospective Study on profile of death due to Hanging was carried out with aim to find out the incidence of deaths due to hanging and considering various factors affecting it and analysing the manner of death. Proper administrative policies can be made based on the involved age group, social factors, education factors, etc. to prevent the death due to hanging.

Need for study: Due to the high prevalence of hanging cases observed, the present study aims to find manner of deaths, studying associated injuries with hanging, understanding socio-demographic factors and possible preventive stratergies.

Materials and methods

This Retrospective study was conducted in the Forensic Medicine and Toxicology Department, Shri M P Shah Government Medical College and Guru Gobindsingh Government Hospital, Jamnagar. All the cases brought to the mortuary for the post mortem examination with alleged history of hanging and post mortem finding suggestive of the same included in this study except the case of exhumation, cases of advance decomposition cases having injury over neck other than the ligature injury of hanging. This study was conducted for 1 year period of time from December 2023 to January 2023 retrospectively.

All the data were obtained from the post mortem examination report, inquest panchnama, requesting letter of police for post mortem examination and marnottar form after the prior permission of the Head of Department, Forensic Medicine & Toxicology to access the documents maintained in the department. All the data like age, sex, religion, socio-economic status and ligature material was studied, analysed and plotted in the table and figure to compare with the studies of the other researcher.

Result and observations

Total no of 224 hanging cases are studied out of total 1231 autopsy performed in our hospital during 1 year period from December 2023 to January 2023.

Out of 224 cases of hanging 149 cases (66.51% of total cases) were male out of it 124 were married, 74 cases (33.03% of total cases) were female and 1 case was transgender **[Fig no. I]**.Most commonly involved age group was 21- 30 years which is 41.52% of total cases. **[Table no. I]**.Study shows out of total cases 196 cases were from Hindu religion and 25 from the Muslim religion. **[Fig no.II]**.

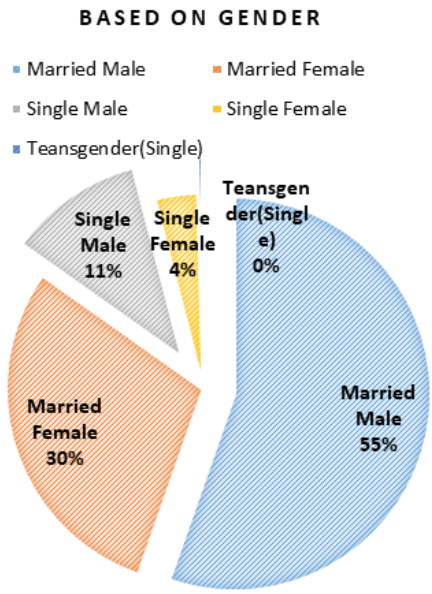


Fig no. I Distribution based on gender

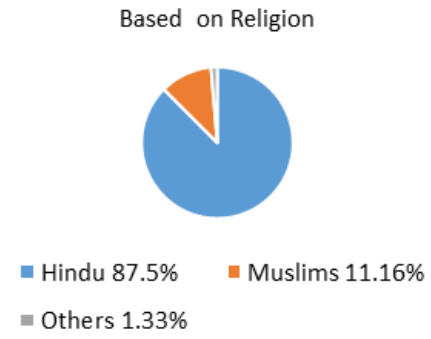


Fig no. II Distribution based on Religion

Table I: Distribution based on Age group

Age Group	No. of Cases
1-10	4
11-20	31
21-30	93
31-40	51
41-50	19
51-60	9
More then 60	17
Total	224

The commonest manner of death observe was suicidal in nature which were 220 cases (98.21% of total cases).4 cases were accidental in nature, among accidental cases 1 case was sexual asphyxial case. Only 29 cases were seen in outdoor setup as a place of hanging. Body of deceased person was decomposed in 22 cases (12.95% of total cases).

Ligature material was found in-situ in 23 cases (10.27% of total cases). Most commonly ligature used was dupatta/saree as observed in this study which is 54.91% of total cases. Hard material like rope, wire, belt and machine belt seen in the 32.59% of the cases, while soft material like dupatta/saree, bed sheet, towel, scarf and dhoti/lungi were seen in 67.41% of cases (151 cases).

In 220 suicidal cases, 63 cases (28.51% of total suicide cases) were due to financial issues. Followed by 51 cases of family or marital conflict (20.08% of total suicide cases). Reasons for committing suicide in 34 case were unknown **[Table no. II]**.

Table no. II Distribution based on Reason for committing suicide

Reasons	No. of Cases
Financial Problems	63
Family/Marital conflict	51
Educational issues	18
Illness	29
Love failure	22
Social Stigma	3
Others/Unknown reasons	34
Total	220

Discussion

This study was carried out with aim to know profile of hanging which include; material used as a ligature, place preferred for hanging, common age group involved, reason for committing suicide and manner of death due to hanging.

Male predominance with 66.51% of total cases of death due to hanging seen in this study which is similar with study done by other authors.[,,] Most common age group involve in this study seen was 21-30 years of age with 41.52% of total cases followed by 31-40 years (22.77% of total cases) which is similar with other studies.[4,5,] As Jamnagar has large hindu population, in this study we found 87.50% cases from the hindu religion. Total 195 cases seen in indoor setup as a place of hanging which is similar with the authors like Jani CB et al.[4], Khartade HK et al.[5] and Vijayakumari.. Most of the people use soft material as a ligature for hanging as in a study of Rao D., Khan R et al. which is similar with present study as 67.41% cases shows use of soft material as a ligature. Saree/ dupatta found most used material in 81.46% cases of total cases which used soft material as ligature, which is similar with study of other authors.[4,5] While Olive B et al.found hard material as a commonly used material which is contrast to present study.

Maximum cases showed suicidal manner of hanging which is 98.21% of total cases, which is similar with other study.[1, 2, 4, 5,7] Only 4 cases were due to accidental hanging as 2 cases in factory work, 1 in pediatric age group and 1 was due to sexual asphyxia.

Conclusion

In modern competitive era and fast growing lifestyle, many people commit suicide when they fail to cop-up with stress or expectations. Social media influence, societal stigma, comparing own life with others, lower literacy and stressful life plays important role in people's life. Young adults and married are commonly victims of the suicide maybe be because of financial crisis, failure of commitments, familial conflict and career related issues. Hanging is commonest method of suicide as is it easy to perform, easily available ligature material and impending rapid death without longer suffering. Suicide partially

can be prevented by education, proper guidance and counselling. Patient with previous history of suicide attempt should undergo counselling and psychiatrist therapy to prevent future attempt.

Ethical Approval

No specific approval from ethical comiittee was taken. The approval from the Head of Department, Forensic Medicine & Toxicology was taken for conducting the restrospective study and accessing the documents related to the research.

Conflicts of Interest: None

Source of Funding: The authors received no financial support for the research, authorship and/or publication of this article.

References

1. Reddy KSN, Murty OP. The Essentials of forensic medicine and toxicology. 35thed. New Delhi: 2012:261-268.
2. Accidental Deaths & Suicides in India 2022 (online). Available from: https://ncrb.gov.in/accidental-deaths-suicides-in-india-year-wise.html?year=2022&keyword=
3. Samanta AK, Nayak SR. Newer trends in hanging death. J Indian Acad Forensic Med. 2012; 34(1):37-39.
4. Jani CB, Gupta BD. An autopsy study of parameters influencing injury to carotid artery in hanging. Journal of Forensic Medicine and Toxicology. 2003;20(1):18-19.
5. Khartade HK, Meshram VP, Pathak HM et al. An autopsy study of death due to hanging with emphasis on ligature material and preligature injuries. Journal of Indian Acad Forensic Medicine. 2019:41(4):237-240.
6. Sharma BR, Harish D, Singh VP, Singh P. Ligature mark on neck: How informative?. J Indian Acad Forensic Med. 2005; 27(1):10-15.
7. Vijaykumar L. Suicide and its prevention: the urgent need in India. Indian j psychiatry. 2007; 49:81-4.
8. Rao D. An autopsy study of suicidal hanging. IP International Journal of Forensic Medicine and Toxicological Sciences. 2021;6(3):108-112.
9. Khan R, Kumar LA. Studies on medico-legal evaluation of material used in hanging in central Orissa. Medico-Legal Update. 2011; 11(2):40-42.
10. Olive B, David G, Navneet K. et al. Suicide by hanging: multicentre study based on coroner's records in England. British Journal of Psychiatry. 2005;186:260-261.

Original Article

DOI: https://doi.org/10.37506/fp65e872

A Prospective Autopsy Study of Hanging Deaths Among Individuals Aged 15–60 Years at Tirunelveli Medical College

Sakthivel K[1], Arun Balan M[2], Pary Prasath M[3], Kaviya K[4], Arun Kumar M[5]

[1,2,3]Assistant Professor, Department of Forensic Medicine, Madurai Medical College, Madurai, [4,5]Junior Resisdent, Department of Forensic Medicine, Madurai Medical College, Madurai.

How to cite this article: Sakthivel K, Arun Balan M, Pary Prasath M. A Prospective Autopsy Study of Hanging Deaths Among Individuals Aged 15–60 Years at Tirunelveli Medical College. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Background: Hanging is one of the most common methods of suicide worldwide, posing significant forensic and medico-legal concerns. This study aims to analyze autopsy findings in hanging cases, focusing on ligature marks, types of hanging, and knot positions.

Methods: This prospective observational descriptive autopsy-based study was conducted over one year at Tirunelveli Government Hospital, Tamil Nadu. A total of 150 cases of hanging were examined. A purposive sampling method was used, including individuals aged 15-60 years. Detailed autopsy findings, including ligature material, neck compression patterns, and other forensic parameters, were recorded and analyzed.

Results: The study provides insights into the distribution of hanging cases concerning age, gender, type of hanging, ligature material used, and knot positioning. The forensic observations contribute to understanding the trends and medico-legal implications associated with hanging deaths.

Conclusion: The findings emphasize the need for awareness and preventive measures to address suicide by hanging. This study aids forensic experts in distinguishing suicide from homicidal hanging and other forms of asphyxial deaths.

Keywords: Hanging, Ligature Mark & Material, Suicidal Thoughts

Introduction:

In India, one of the most common methods of suicide is hanging. Tirunelveli is one of the most highly populated areas in Tamil Nadu, with an approximate population of 6 to 7 million. Due to population explosion, poverty, and increasing stress and strain in our daily lives, we frequently come across cases of suicide.

"Death is an inevitable aspect of life, but among living beings, only humans exhibit the capacity to end their own lives through suicide." There are many methods for committing suicide, like poisoning, hanging, self-immolation, and drowning, etc. Hanging is one of the most common, as the materials necessary are easily available and have

Corresponding Author: Kaviya K, Junior Resisdent, Department of Forensic Medicine, Madurai Medical College, Madurai.

E-mail:

Submission date: May 15, 2025 **Acceptance date:** July 21, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

of high success rate. Hanging is a form of asphyxia caused by body suspension by a ligature around the neck, the constricting force being the body's weight (complete hanging) or part of the body's weight (partial hanging).[1]

The term typical hanging is applied when the point of suspension is placed centrally over the occiput, i.e., the knot is at the nape of the neck on the back. If the point of suspension is at any other position, then the term atypical hanging is often applied.

Hanging materials were easily accessed, and respondents considered it 'simple' to perform without the need for planning or technical knowledge. Hanging was thus seen as the 'quickest' and 'easiest' method with few barriers to completion and sometimes adopted despite not being a first choice[3].

"Psychological distress is a significant factor contributing to suicidal tendencies, as evidenced by various mental health studies."

By careful recording of the circumstances of the hanging case, any readily available material may be used as a ligature in cases of hanging. Common ligatures include soft fabrics such as dhotis (a traditional Indian men's garment), sarees (a long piece of cloth worn by women), or bed sheets. In many instances, individuals use whatever material is easily accessible at the location, as suicide by hanging is often an impulsive act.

To enhance understanding, here are images of the commonly used ligature materials:

1. **Dhotis** – A traditional Indian garment worn by men, often made of cotton.

Photographs: Below Photographs are Collected From Investigating Officers who Brought the Cases for Autopsy in Thirunelveli Medical College Morgue



Figure No 1: Dhoti as Ligature Material, in Thirunelveli Medical College Morgue

2. **Sarees** – A long-draped garment worn by women, typically made of silk, cotton, or synthetic fabrics.



Figure no 2: Saree as Ligature Material, in Thirunelveli Medical

3. **Bed sheets** – Readily available household items often used in impulsive acts of self-harm.



Figure No 3: Using Towel and Lungi as Hanging Material, in Thirunelveli Medical College Morgue


FIGURE NO:4, SHOWS PLASTIC COIR AS LIGATURE WITH LIGATURE NOTED IMPRESSION,IN THIRUNELVELI MEDICAL COLLEGE MORGUE

Review of Literature:

1. Choice of Method – Preference for Hanging Biddle et al. (2010)[3] conducted a qualitative study and observed that hanging was perceived as a quick, easily accessible, and painless method of suicide, requiring minimal preparation. This aligns with our findings, where commonly available ligature materials such as sarees and bedsheets were used, indicating impulsivity and ease of execution.
2. Epidemiology and Age Distribution Meel (2006)[4] reported a high frequency of suicide by hanging among young adults in South Africa, consistent with our study, where the majority of cases (45.33%) occurred in the 21–30 years age group. Similarly, the NCRB (2010)[5] data emphasized that a large proportion of suicides in India occur in reproductive age groups, particularly males in their 20s and 30s, matching our demographic findings.
3. Male Predominance in Hanging Robert and Pauline (2000)[8] highlighted that males are more prone to hanging, especially in the context of youth suicide. The study also revealed a male-to- female ratio of 2:1, supporting this gender disparity.
4. Impulsivity and Material Availability David et al. (2005)[7] in their systematic review found that ligature choice was primarily dictated by availability, with bedsheets and clothing items commonly used. The findings showed sarees (46%) and dupattas (40.67%) as the most used materials, emphasizing impulsive acts with accessible means.
5. Knot Position and Hanging According to Saini et al. (2005)[11], the knot position and hanging type can offer insight into the manner of death. The study found atypical hangings to be more frequent than typical ones (38.3% vs. 11.67%) and detailed the predominance of ligature marks above the thyroid cartilage.
6. Motive and Socio-cultural Factors Sharija et al. (2011)[10] in Kerala reported that marital disharmony and family conflicts were leading causes of suicide by hanging, comparable to our findings, where 43% of cases were attributed to marital discord, followed by financial problems and unemployment.
7. Regional Trends in India Ahmad and Hossain (2010)[9] emphasized that hanging remains the most common method of suicide in rural South Asia due to simplicity and fatality.

Objectives: The objectives of the study are the following:

1. To study the incidence of hanging deaths reported at Tirunelveli Medical College
2. Age and sex distribution, and other socioeconomic factors of the deceased in hanging cases.

Design:

This study is a prospective autopsy-based analysis conducted over one year at Tirunelveli Government Hospital (GRH), Tirunelveli, Tamil Nadu.

Sample Size: A total of 150 deceased individuals who died due to hanging were included in the study.

Sampling Technique: A purposive sampling method was employed, in which all cases of hanging autopsies at Tirunelveli Medical College during the study period within the age group of 15-60 years were included.

Sources: The study analyzed different types of hanging, ligature marks, ligature materials, and the position of knots in deceased individuals brought for autopsy from Tirunelveli and nearby districts. The analysis was conducted using SPSS 16, and the results were presented in terms of percentage and mean.

Descriptive statistics were used, and statistical significance was tested using the chi-square and z-test. All the statistical procedures were performed on separate data collection sheets using SPSS 16 software and run under Microsoft Windows XP.

Research Gap: While numerous studies have explored the forensic aspects of hanging, there remains a lack of region-specific data, particularly in the southern districts of Tamil Nadu. Existing research primarily focuses on broad epidemiological trends, but detailed autopsy-based studies analyzing ligature marks, knot positioning, and ligature material variations are limited. Furthermore, the influence of socio-economic and cultural factors on hanging cases remains underexplored.

Need for the Study: Understanding the forensic characteristics of hanging is crucial for accurate medico-legal investigations. This study aims to bridge the research gap by providing detailed autopsy- based findings, which can assist forensic experts, law enforcement agencies, and policymakers in developing preventive measures. The study will also contribute to distinguishing suicidal hangings from homicidal cases, ensuring more precise forensic interpretations.

Results

The results were documented retrospectively in an autopsy-based study. In the majority of the hanging cases, there were Male victims in 100 cases. Most of the victims were in the age group of 21-30 years, 69(45.33%). The motive of the suicidal thoughts mainly belonged to the marital harmony, 64 cases (43.3%), saree was commonly used ligature material than others. Most of the hangings are atypical and complete types. The most common Point of suspension used was the ceiling rod in 75 cases (49.57%). Characteristics of Ligature marks are, in most cases, prominent, and the level of ligature marks is above the thyroid cartilage in 123 cases (82%). In this study, only 6 cases had hyoid bone fracture; it is also a standing hanging case with a long period of suspension time.

A total of 150 deceased victims' autopsy reports were analysed, and the following results were found.

Age Wise Distribution:

The distribution of study subjects according to age is depicted in Figure 1.

The most vulnerable age for hanging is found to be between 21 and 30 years, wherein 45.33% of deaths occurred. The next vulnerable age group is 31-40 years, in which 22% of deaths occurred.

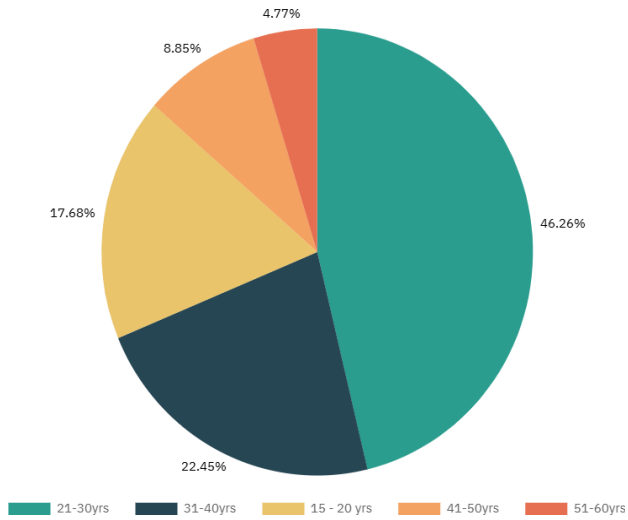


Figure No 1: Age Wise Distribution

Sex Wise Distribution

The male-to-female ratio is 2:1. Males outnumbered the females in the present study (66.81% are males and 33.19% are females).

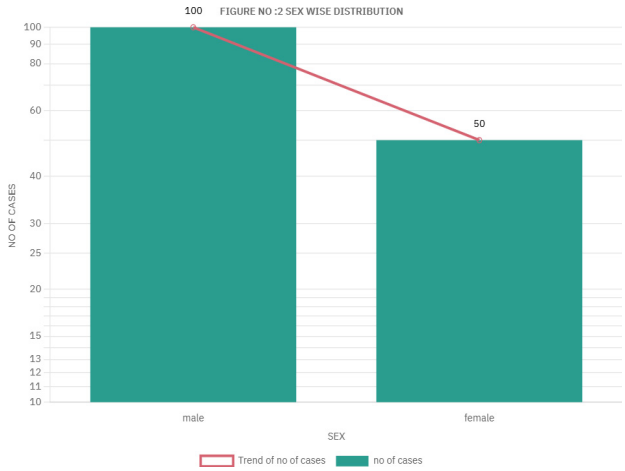


Figure No 2: Sex Wise Distribution

Motive

In the present study, marital disharmony was claimed by 43%. Financial problems accounted for 12.94%, and chronic physical pain accounted for 18%. Other motives behind hanging were love failure (9%), unemployment(10.11%), and psychiatric(6.89%).

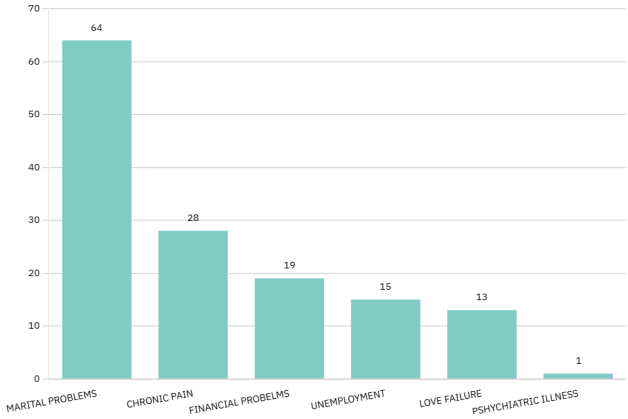


Figure No 3: Motives for Death

Ligature Material

When we compare ligature material, sarees were used frequently for hanging and accounted for deaths (46%), and also other ligature materials like Dupatta (40.67%). Plastic rope was used in 20% of the cases. Dhoti (14.67%) and(0.62.% %). Electric wire;(10.67%) coir rope as ligature material.

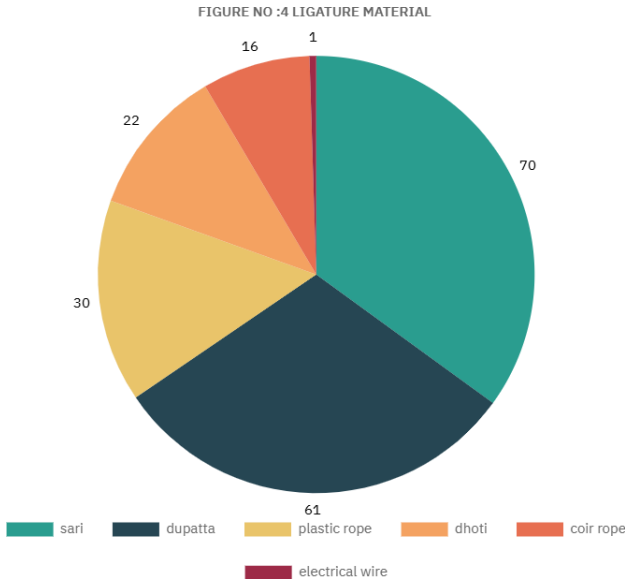


Figure No 4: Variants of Ligature Material

Point of Suspension

Most of the people in the study population are choosing a ceiling rod(49.57%) as a point of suspension, followed by a ceiling fan (43.54%). The rest of the points of suspension were trees (2.58%) and other suspension points like window grills, staircase handles, and door handles, which accounted for 4.31%.

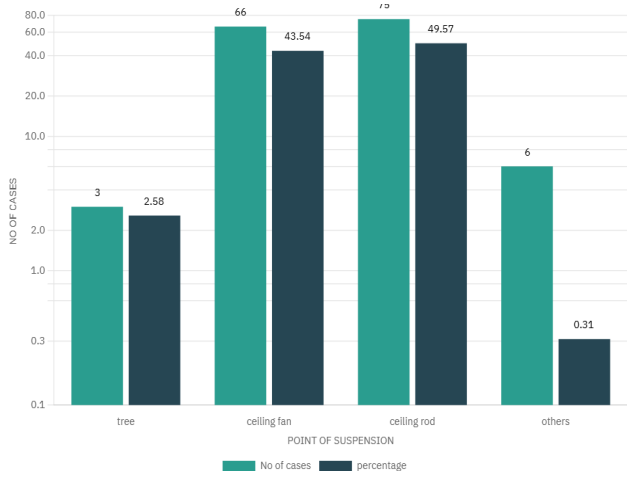


Figure No 5: Point of Suspension material

Type of Hanging

Hanging deaths can be categorized based on their execution into typical/atypical and complete/partial types. In this study, atypical hangings (38.3%) were the most common, followed by complete hangings (32.6%), partial hangings (17.33%), and typical hangings (11.67%). Among males, 17.33% of cases involved typical hanging.

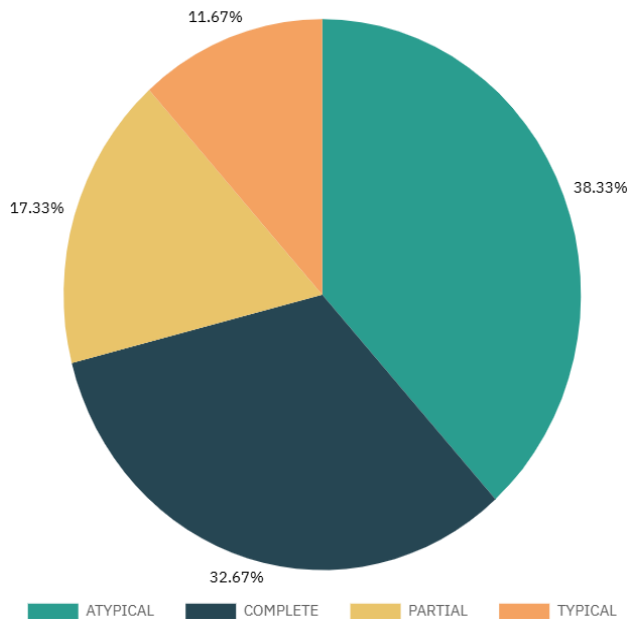


Figure No 6: Types of Hanging

Level of Ligature Mark

In the present study, it is observed that in 82% of cases, the level of the ligature mark was above the thyroid cartilage, below the thyroid cartilage in

6.67% of cases, and overriding the thyroid cartilage in 11.33% of cases.

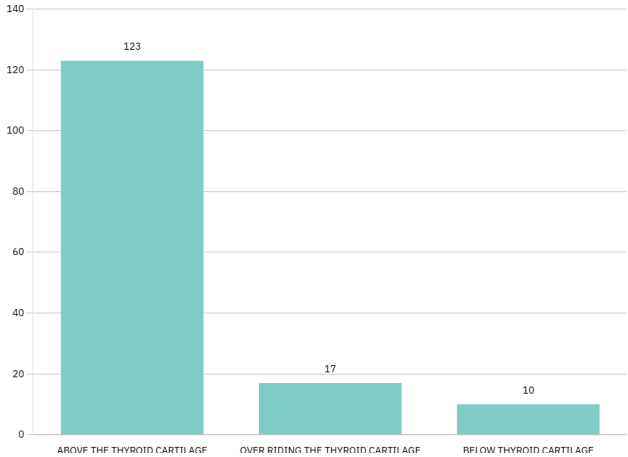


Figure No 7: Level of Ligature Mark

Fracture of the Hyoid Bone

In the present study, no fracture was noted in 144 cases. Fracture of the great cornu of the hyoid bone on the right was observed in 6 cases. The reason is that the fracture increases with age, a high level of ligature marks on the neck, increased duration of suspension, and with a thin, hard ligature material.

Table No 2: Fractue of Ligature Mark

FRACTURE OF HYOID BONE	
PRESENT	6
ABSENT	144

NEW AND UNEXPECTED FINDINGS

Atypical hanging was more prevalent than typical hanging, challenging conventional forensic expectations.

The majority of ligature marks were found above the thyroid cartilage, suggesting that a predominant hanging technique was used in the study population.

A significant proportion of cases involved ligature materials like sarees and bedsheets, highlighting the accessibility and impulsive nature of the act.

Contrary to previous studies, a noticeable number of cases were found in certain socio-economic groups, indicating possible socio-cultural or economic stressors influencing the choice of hanging as a method of suicide.

IMPLICATIONS OF THE STUDY

This study offers several critical forensic insights and practical implications for understanding hanging deaths in the Tirunelveli region:

Enhanced Crime Scene Analysis: The identification of commonly used ligature materials (sarees, bedsheets) and the predominance of atypical hanging can improve forensic investigations by helping experts distinguish between suicidal and homicidal hangings.

Region-Specific Forensic Profiling: The study provides crucial data specific to the southern districts of Tamil Nadu, bridging a significant research gap. It highlights socio-economic factors influencing suicide, including marital discord, financial problems, and mental health issues.

Standardization of Post-Mortem Protocols: Understanding the distribution of ligature marks (predominantly above the thyroid cartilage) can guide forensic pathologists in accurately documenting and analyzing hanging cases.

Mental Health Interventions: The findings emphasize the importance of targeted mental health support, particularly for young adults aged 21-30 years, who were most vulnerable in this study. Awareness campaigns and counseling should focus on this demographic.

Policy Recommendations for Suicide Prevention: Given the socio- demographic patterns identified, policymakers can develop region- specific suicide prevention strategies, including educational programs and mental health support in workplaces.

Educational and Training Applications: The study's findings can serve as a reference for forensic training programs, helping professionals recognize specific hanging characteristics and improve their diagnostic accuracy.

Further Research Directions: This study highlights the need for further research into the socio-cultural factors influencing suicide methods and the psychological triggers among different age groups.

Discussion

The present study analyzed 150 cases of hanging deaths in the Tirunelveli region, with the majority of

victims being males (66.81%) and predominantly in the 21–30 years age group (45.33%). These findings are consistent with earlier studies, such as the work by **Biddle et al.**[11] and **Ahmad & Hossain**, which also report a higher incidence of hanging among young adult males, highlighting socio-economic and psychological stress as significant contributing factors.

The predominance of atypical hangings (38.3%) in this study contrasts with some traditional forensic reports where typical hangings (knot at the nape) were more frequent (**DiMaio & DiMaio**[2]). This discrepancy may be due to cultural or regional differences in ligature material use and methods of suspension, which our study detailed with sarees and bedsheets being common ligatures.

Ligature marks were most commonly located above the thyroid cartilage (82%), aligning with findings from **Reddy**[1], who noted that the ligature mark's position often depends on the knot placement and the type of suspension. The occurrence of hyoid bone fractures was low (4%), consistent with studies suggesting fractures increase with age and the use of harder ligature materials (**Meel**).

The primary motives identified—marital disharmony (43%), financial problems, and psychiatric illness—reflect socio-cultural stressors specific to this region and corroborate findings by **Sharija et al.**[1] in Kerala, indicating that family and economic pressures are common precipitants for suicide by hanging in southern India.

The point of suspension, predominantly ceiling rods and fans, reflects the accessibility of hanging points in domestic settings, which is similar to observations made by **Robert & Pauline**. This highlights the impulsive nature of many hanging suicides and suggests potential preventive measures focusing on restricting access to common suspension points.

Overall, the study reinforces the need for culturally sensitive suicide prevention programs tailored to young adults in the region, emphasizing mental health support and community awareness. Future studies could explore in-depth psychological profiling and longitudinal follow-ups to better understand the underlying causes and prevention strategies.

Conclusion

The result of the study is mainly focused on hanging cases brought for autopsy. It helps us to differentiate the different ligature marks and ligature material and predisposing factors responsible for suicidal thoughts. Avoidance of suicidal death by promoting psychological counselling about dowry-related death and marital relationship, and social and psychological behaviour support by organizing NGO groups among students, work stations, and companies.

Limitations:

The limitations of this study include the fact that the Study was confined to a particular area (Tirunelveli district), the areas which come under Tirunelveli Medical College and hospital jurisdiction.

Information regarding the head's ceased is based only on the history provided by the Police, Relatives, the Inquest, and the Photograph of the scene of occurrence.

Recommendation:

The medical community's primary recommendations should focus on counselling, improved psychiatric care, and better access to medical treatment. In recent times, increased use of mobile phones to watch suicide-related content, engagement in online games promoting self- harm, and substance abuse have contributed to rising suicidal tendencies.

To prevent suicide by hanging, various approaches should be implemented, including restricting access to ligature materials and suspension points and reducing the lethality of suicide attempts. For individuals who survive a hanging attempt, prompt pre-hospital care and acute medical intervention can significantly improve survival outcomes.

Early intervention programs, such as counselling and access to mental health professionals, should be strengthened, particularly in educational institutions. Providing students with mental health support can help prevent suicidal thoughts.

Additionally, proper psychological counselling on mental well-being, substance abuse prevention, responsible mobile phone usage, reduced social media exposure, and avoidance of alcohol and drug addiction can play a crucial role in guiding young individuals away from harmful behaviors.

Foot Notes:

Sources of support: NIL

Conflict of interest: NONE

Ethical Clearance: Ref no:1397/FM/2018, Approval given by Dr J Suresh Durai, MD, Member Secretary, TIREC, Thirunelveli Medical College.

References

1. Reddy KS. The essentials of forensic medicine and toxicology. 30th ed. Hyderabad: Publisher; 2011. p. 308–315.
2. DiMaio VJ, DiMaio D. Forensic pathology. 2nd ed. CRC Press LLC; 2001. p. 264–273.
3. Biddle L, Donovan J, Owen-Smith A, Potokar J, Longson D, Hawton K, et al. Factors influencing the decision to use hanging as a method of suicide: Qualitative study. Br J Psychiatry. 2010;197(4):320–5. doi:10.1192/bjp.bp 109.076349.
4. Meel B. Epidemiology of suicide by hanging in Transkei, South Africa. Am J Forensic Med Pathol. 2006;27(1):75–8.
5. National Crime Records Bureau. Accidental deaths and suicides in India, 2010. New Delhi: National Crime Records Bureau; 2010.
6. Capital punishment in India.
7. David G, Olive B, Keith H, Sue S, Nav K. The epidemiology and prevention of suicide by hanging: A systematic review. Int J Epidemiol. 2005;34(2):433–42. doi:10.1093/ije/dyh398.
8. Robert JK, Pauline D. Death by hanging: Implications for prevention of an important method of youth suicide. Aust N Z J Psychiatry. 2000;34(5):836–41. doi :10.1080/j.1440-1614.2000.00807.
9. Ahmad M, Hossain MZ. Hanging as a method of suicide: Retrospective analysis of postmortem cases. JAFMC Bangladesh. 2010;6(2):37–9
10. Sharija S, Sreekumari K, Geetha O. Epidemiological profile of suicide by hanging in southern parts of Kerala: An autopsy-based study. J Indian Acad Forensic Med. 2011;33(3):237–40.
11. Saini OP, Saini PK, Jain R, Mathur PN. Position of a knot in the neck & relation with the working hand in cases of hanging. Int J Indian Forensic Med Toxicol. 2005;3(1).

Original Article

DOI: https://doi.org/10.37506/akkh2t49

A Retrospective Study on the Impact of Early Hemoperfusion on Survival Outcomes in Acute Paraquat Poisoning

Kishore R[1], Varun Byrappa[2], Arun A Mohanan[3], Shreyas Satish[4], Anup Kumar Roy[5]

[1]MBBS (Junior Resident, Department of Emergency Medicine), Kempegowda institute of medical sciences, Bengaluru, [2]MBBS.MD.DNB.FNB.EDIC, Kempegowda institute of medical sciences, Bengaluru, [3]MBBS.MD.DNB, Kempegowda institute of medical sciences, Bengaluru, [4]MBBS.MD, Kempegowda institute of medical sciences, Bengaluru, [5]MBBS, Kempegowda institute of medical sciences, Bengaluru.

How to cite this article: Kishore R, Varun Byrappa, Arun A Mohanan et. al. A Retrospective Study on the Impact of Early Hemoperfusion on Survival Outcomes in Acute Paraquat Poisoning. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Background: Paraquat (PQ) (1,1′-dimethyl-4,4′-bipyridinium dichloride) poisoning is a major global health issue, especially in developing countries. PQ accumulates in pneumocytes, causing cellular damage through reactive oxygen species and leading to pulmonary fibrosis. Despite medical advances, severe cases have a mortality rate exceeding 80%.

Methods: This retrospective observational study analyzed 30 patients over six months in the Emergency Medicine Department (ED) of a tertiary hospital in India. Adults (≥18 years) with confirmed paraquat poisoning, via history or positive urine dithionite test, admitted between January 2024 and June 202,4 were included after obtaining ethical committee approval. Cases were identified using ICD-10 code T60.3 and ED records. Data collected included demographics, poisoning details (e.g., time, quantity, time of presentation to ED) and clinical features like respiratory distress, altered mental status, and organ dysfunction. Patients who received early hemoperfusion (within 4 hours) of paraquat ingestion had a significantly higher survival rate compared to those who received it later.

Conclusion: The timing of HP administration appears to be associated with 30-day mortality, as indicated by the significant p-value (0.045), suggesting a potential relationship between delayed HP and higher mortality rates.

Keywords: Paraquat(PQ), Hemoperfusion (HP), Retrospective study, Acute kidney injury, Mechanical ventilation

Introduction

Paraquat (PQ) (1,1′-dimethyl-4,4′-bipyridinium dichloride) poisoning represents a significant global health challenge, particularly in developing nations where it remains widely accessible as an agricultural herbicide.[1] PQ toxicity involves the selective accumulation of PQ in pneumocytes through active transport systems, followed by redox cycling that generates reactive oxygen species, leading to cellular

Corresponding Author: Kishore R, MBBS Junior Resident, Department of Emergency Medicine, Kempegowda institute of Medical sciences, Bengaluru

E-mail: Kishorejack58@gmail.com

Submission date: June 5, 2025 **Acceptance date:** July 29, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

death and the progression to pulmonary fibrosis.[2] Despite advances in medical care, mortality rates in PQ poisoning consistently exceed 80% in emergency department presentations.[3]

The pharmacokinetics of PQ demonstrate a critical early phase where plasma concentrations peak within 1-3 hours post-ingestion, followed by rapid tissue distribution. Research has established that once PQ accumulates in lung tissue, the prognosis becomes extremely poor, with conventional treatments showing limited efficacy.[4] This distribution pattern suggests a narrow therapeutic window during which early intervention might prevent significant tissue accumulation. Current ED protocols typically incorporate hemoperfusion (HP) as a primary therapeutic modality, but the timing of its initiation varies significantly across centers, often delayed by several hours after presentation.[5] Currently, emergency departments face challenges including delayed recognition of PQ poisoning, variability in diagnostic confirmation methods, and logistical barriers to rapid HP initiation. Understanding the impact of early HP in this setting could lead to standardized protocols that optimize the use of this potentially life-saving intervention during the crucial early hours post-ingestion.

Methods

This retrospective observational study analyzed 30 patients for 6 months duration at the Department of Emergency Medicine, Kempegowda Institute of Medical Sciences, Bangalore, India.[6] The inclusion criteria for the study required participants to be at least 18 years old with a history of paraquat poisoning and to have been admitted over 6 months between January 2024 and June 2024. A confirmed diagnosis was necessary, either through an identifiable documented history of ingestion or a positive urine dithionite test. Institutional ethical clearance was obtained. Cases were identified through ICD-10 code T60.3 and emergency department registers.[7] Basic demographic details and specifics of poisoning such as age, gender, occupation, marital status, time of ingestion, approximate quantity consumed, and time elapsed before hospital presentation were collected. Respiratory distress, altered mental status, and signs of organ dysfunction at presentation were recorded from the hospital records.

Respiratory distress is defined as a respiratory rate of more than 22 cycles per minute (cpm) according to the Quick Sequential Organ Failure Assessment (qSOFA) criteria.[8] Altered mental status is defined as a Glasgow Coma Scale (GCS) score less than 15, according to the qSOFA criteria. Organ dysfunction is defined as an increase in the Sequential Organ Failure Assessment (SOFA) score by 2 points or more, according to the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3).[9] Outcome variables include length of hospital stay, functional status, and all-cause mortality in 30 days. Functional status improvement of patients has been evaluated in terms of worsening renal function tests [AKI], respiratory failure, and the need for mechanical ventilation.

Results

Table 1: Comparison of demographic factors

Socio-economic status	Variables	HP within 4 hours	HP after 4 hours	p value
Age (in years)	<=20	3 (20.0)	2 (13.3)	0.201
	21 - 35	8 (53.3)	6 (40.0)	
	36 - 50	4 (26.7)	3 (20.0)	
	> 50	0 (0.0)	4 (26.7)	
Gender	Males	9 (60.0)	7 (46.7)	0.464
	Females	6 (40.0)	8 (53.3)	
Education	Up to high school	9 (60.0)	8 (53.3)	0.713
	College and above	6 (40.0)	7 (46.7)	

Table 1 shows that the analysis of socio-economic factors in relation to the timing of hemoperfusion (HP) revealed no statistically significant associations. Out of 30 patients, Mean Age is 34.30 ± 3.67 years. The gender distribution of the study was male 53% and female 47%.Younger patients (aged ≤35 years) were more likely to receive HP within 4 hours, while older individuals (>50 years) tended to receive it later because the time of presentation is earlier in the case of young adults. Gender distribution, education of the patients were comparable between the two groups (HP <4 hours vs HP>4 hours).

Table 2: Comparison of complications within 4 hours vs after 4 hrs

Complications	Variables	HP within 4 hours	HP after 4 hours	p value
Acute Kidney Injury	Present	3 (20.0)	7 (46.7)	0.047
	Absent	12 (80.0)	8 (53.3)	
Respiratory failure	Present	4 (26.7)	9 (60.0)	0.039
	Absent	11 (73.3)	6 (40.0)	
Mechanical ventilation	Present	5 (33.3)	9 (60.0)	0.143
	Absent	10 (66.7)	6 (40.0)	

The occurrence of complications has shown notable differences concerning the timing of hemoperfusion (HP), as in Table [2]. Acute kidney injury (AKI) was significantly more common among patients who received HP after 4 hours (46.7%) compared to those treated earlier (20.0%), with a p-value of 0.047. Similarly, respiratory failure was more prevalent in the delayed HP group (60.0%) than in the early HP group (26.7%), with a p-value of 0.039. Although mechanical ventilation was more frequently required in the late HP group (60.0% vs. 33.3%), this difference was not statistically significant (*p = 0.143*). Overall, complications were generally more common in patients receiving delayed HP.

Table 3: Comparison of outcomes within 4 hrs vs after 4 hrs

Outcomes	Variables	HP within 4 hours	HP after 4 hours	p value
Length of hospital stay	<30 days	8 (53.3)	11 (73.3)	0.256
	>30 days	7 (46.7)	4 (26.7)	
Functional status	Improved	5 (33.3)	2 (13.3)	0.224
	Same	3 (20.0)	1 (6.7)	
	Worse	7 (46.7)	12 (80.0)	
30-day mortality	Present	7 (46.7)	12 (80.0)	0.045
	Absent	8 (53.3)	3 (20.0)	

Among patients who received hemoperfusion within 4 hours, 8 (53.3%) had hospital stays of less than 30 days, compared to 11 (73.3%) in the delayed HP group. Conversely, prolonged hospital stays (>30 days) were observed in 7 (46.7%) of early HP patients and 4 (26.7%) of delayed HP patients. This difference was not statistically significant (*p* = 0.256), as shown in Table [3].

However, this difference was not statistically significant (*p = 0.256*). Functional status also varied by timing, with improved outcomes seen more often in the early HP group (33.3%) compared to the delayed group (13.3%). Conversely, patients with worsened functional status were predominantly in the delayed HP group (80.0%), though these findings were not statistically significant (*p = 0.224*). The timing of hemoperfusion was significantly associated with 30-day mortality. Among patients who received delayed hemoperfusion, 12 (80%) died within 30 days, compared to 7 (46%) among those who received early hemoperfusion (*p* = 0.045). Functional status at 30 days showed a trend favouring early hemoperfusion (*p* = 0.224). Among patients who received hemoperfusion within 4 hours, 3 (20.0%) had unchanged status and 7 (46.7%) worsened, while 2 (13.3%) of those who received delayed hemoperfusion improved, 1 (6.7%) remained unchanged, and 12 (80.0%) worsened.

Discussion

The initial hours following PQ ingestion represent a critical window where appropriate intervention could significantly alter patient outcomes.

In contrast to the observations from previous studies that suicidal ideation and attempts are more common among older age groups compared to younger adults, our study has shown that most patients affected by paraquat poisoning are in younger age group.[10] The reason for the same might be the availability of knowledge about the poison in younger adults compared to the older age groups.

Experimental evidence has demonstrated that HP initiated within 4 hours of PQ exposure significantly reduces mortality rates. All-cause mortality in 30 days in patients with HP initiated within 4 hours is significantly lower when compared to HP later than 4 hours (46% vs 80%, with a p-value of 0.045). Ying-Tse Yeh et al reported mean days of mortality as 4.2 days HP group and overall mortality of 80%, similar to the findings of our study. The survival time of the early HP group was not significantly higher than the late HP group.[11] Mortality depends on the time of presentation, early intervention and the amount of herbicide ingestion.

Functional status, assessed in terms of clinical and laboratory outcomes, also trended towards better outcomes in the early HP group. A larger proportion of patients treated early showed functional improvement compared to those treated later with HP (33.3% vs 13.3%) and fewer had deteriorated outcomes (46.7% vs 80.0%). [11] These trends suggest clinical relevance and underscore the importance of early intervention, even if not definitively proven within this cohort. [11] In studies done with larger sample sizes it has been proven that the liver function tests, renal function tests and blood gas indices showed significant improvement with early HP.[12,13]

A greater percentage of patients in the late HP group had hospital stays of fewer than 30 days.

However, this likely reflects early mortality rather than faster recovery, highlighting the importance of interpreting length of stay within the context of survival outcomes.

The major barrier to the implementation of early HP is logistical. In real-world emergency settings, delayed diagnosis, lack of rapid confirmatory tests and limited availability of HP equipment and trained personnel contribute to treatment delays in low and middle income countries. Therefore, standarzing protocols for the early recognition of parquat poisoning and immediate initiation of HP could significantly improve survival outcomes.[14] Point of care tests like urine dithionite test can aid in rapid diagnosis.

The pathophysiological basis for early HP intervention is supported by evidence demonstrating that PQ accumulation in lung tissue occurs through an active transport mechanism that becomes increasingly difficult to reverse once established.[15] These findings align with PQ's toxicokinetic profile, suggesting that early removal from circulation might prevent critical tissue accumulation thresholds. [16] However, the translation of these findings into emergency department practice faces challenges, including the optimal timing for HP initiation and the practical barriers to implementing early HP in clinical settings. This understanding has important implications for emergency response protocols and resource allocation in toxicology units. In the emergency department setting, the establishment of clear protocols for early HP is particularly crucial, as it represents the first point of medical contact for most poisoning cases.

Strengths:

This study addresses a highly lethal and under-researched form of poisoning and contributes valuable insights into optimising emergency treatment protocols, specifically the timing of hemoperfusion.

Limitations:

The study was conducted in a single institution, which may limit the generalisability of results to other settings, especially those with different resource availability or treatment protocols.

Conclusion:

In patients with paraquat poisoning, treatment with early hemoperfusion significantly improved 30-day survival rates. There is a reduced incidence

of kidney and respiratory failure among patients receiving early hemoperfusion therapy. This study reinforces the critical role of early hemoperfusion in improving survival and reducing complications in acute paraquat poisoning. While early HP significantly lowers mortality, its full impact depends on timely diagnosis, quick access to specialised care, and supportive treatment protocols. Larger multicentric studies and prospective designs would be beneficial to confirm these results and guide standardised emergency response strategies for PQ poisoning.

Conflict of Interest: No conflict of interest has been reported by any of the authors of this study

Source of Funding: Nil

Ethical Clearance: Has been taken from the institutional ethical committee, Kempegowda Institute of Medical Sciences, Bengaluru.Ref no:KIMS/IEC/A239/M/2025

References

1. Dawson AH, Eddleston M, Senarathna L, Mohamed F, Gawarammana I, Bowe SJ, et al. Acute Human Lethal Toxicity of Agricultural Pesticides: A Prospective Cohort Study. PLoS Med 2010 Oct 26;7(10):e1000357.
2. Suntres ZE. Role of antioxidants in paraquat toxicity. Toxicology 2002;180(1):65–77.
3. Gil H wook, Hong JR, Jang SH, Hong SY. Diagnostic and Therapeutic Approach for Acute Paraquat Intoxication. J Korean Med Sci 2014 Nov 4;29(11):1441–9.
4. Gawarammana IB, Buckley NA. Medical management of paraquat ingestion. Br J Clin Pharmacol 2011;72(5):745–57.
5. Mohamed F, Endre ZH, Buckley NA. Role of biomarkers of nephrotoxic acute kidney injury in deliberate poisoning and envenomation in less developed countries. Br J Clin Pharmacol 2015 Jul;80(1):3–19.
6. Hsu CW, Lin JL, Lin-Tan DT, Chen KH, Yen TH, Wu MS, et al. Early Hemoperfusion May Improve Survival of Severely Paraquat-Poisoned Patients.2012;7(10):e48397.
7. Free 2025 ICD-10-CM Codes [Internet].
8. Comparison of QSOFA score and SIRS criteria as screening mechanisms for emergency department sepsis. 2017 Nov;35(11):1730-33
9. Sepsis 2018: Definitions and Guideline Changes. 2018 Feb;19(2):117-25
10. Risk factors for suicide in elderly in comparison to younger age groups:2015 July;57(3):249-54
11. Yeh YT, Chen CK, Lin CC, Chang CM, Lan KP, How CK, et al. Does Hemoperfusion Increase Survival in Acute Paraquat Poisoning? A Retrospective Multicenter Study. Toxics 2020 oct ;8(4):84.
12. Guo H, Yuan Y, Ma Y, Shi J, Gu H. Effects of early repeated hemoperfusion combined with hemodialysis on the prognosis of patients with paraquat poisoning. Am J Transl Res 2023 Sep 15;15(9):5613-23
13. Zou LJ, Li SH. Effects of intensive hemoperfusion on the toxin clearance, target organ function and oxidative stress in patient with paraquat poisoning.2012 Feb;30(2):89-96
14. Mottla ME, Bowler ME, Asgary R. Epidemiology, risk factors, and strategies to prevent and manage poisonings due to pharmaceuticals in children in low income and low-middle income countries: A systematic review. J Glob Health 2023;13:04173.
15. Roberts DM, Buckley NA. Pharmacokinetic considerations in clinical toxicology: clinical applications. Clin Pharmacokinet 2007;46(11):897–939.
16. Kim JH, Gil HW, Yang JO, Lee EY, Hong SY. Serum uric acid level as a marker for mortality and acute kidney injury in patients with acute paraquat intoxication. Nephrol Dial Transplant 2011;26(6):1846–52.

Original Article

DOI: https://doi.org/10.37506/e9kjjz92

Assessment of Sexual Dimorphism Using External Ear Morphometry: A Cross-Sectional Study Among Adults in Bardhaman, West Bengal

Madhavi Phulambrikar (Keole)

Assistant Professor of Anatomy, Dr. Rajendra Gode Medical College, Amravati, Maharashtra. Former postgraduate student, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

How to cite this article: Madhavi Phulambrikar (Keole). Assessment of Sexual Dimorphism Using External Ear Morphometry: A Cross-Sectional Study Among Adults in Bardhaman, West Bengal. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Introduction: The sexual dimorphism based on morphometric ear variables of the adult Indian population is highly under-explored. Morphometry of external ear from other countries cannot be directly applicable to the Indian population.

Aims and Objectives: This study aimed to evaluate morphometric parameters of the external ear among adult Bengali population to assess sex-based differences.

Materials and Method: A descriptive, cross-sectional study was conducted at the Burdwan Medical College and Hospital from March 2021 to March 2022, involving 146 males and 146 females. Right (RT) and Left (LT) Auricle length (AL), Auricle Width (AW), Lobule Length (LL), and Lobule Width (LW) were measured using vernier calipers. Auricle Index (AI) and Lobule Index (LI) were calculated. Two-tailed paired t-test was performed between the corresponding variables of males and females.

Result: Right Auricle Length (RTAL), Auricle Width (RTAW), Lobule Length (RTLL), Lobule Width (RTLW) and Lobule Index (RTLI) showed significant sexual dimorphism. Left Auricle Width (LTAW), Lobule Length (LTLL) and Lobule Width (LTLW) also showed significant differences ($p < 0.05$).

Conclusion: The result suggests significant sexual dimorphism in external ear morphometry among the Bengali population. The assessment of ear morphometry using a simple and direct technique can be useful during forensic investigations. These preliminary findings indicate that ear morphometry can be used as a supportive tool in forensic anthropology and biometric identification.

Keywords: Sexual Dimorphism, Ear Morphometry, External Ear, Biometric Identification, Bengali Population, Forensic Anthropology Assessment of Sexual Dimorphism Using External Ear Morphometry: A Cross-Sectional Study Among Adults in Bardhaman, West Bengal.

Corresponding Author: Madhavi Phulambrikar (Keole), Assistant Professor of Anatomy, Dr. Rajendra Gode Medical College, Amravati, Maharashtra. Former postgraduate student, Burdwan Medical College and Hospital, Bardhaman, West Bengal.

E-mail: madhavi.phulambrikar@gmail.com

Submission date: June 28, 2025 **Acceptance date:** August 1, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

Introduction

Auricle (Pinna)[1] is the external part of the ear (Fig.-1), projected on the side of the head. It collects sound waves and conducts them towards the tympanic membrane[2].

The auricle has two surfaces - lateral and medial[3]. On the irregular lateral surface, a triangular projection called the tragus, and an elevation - antitragus are separated by an intertragic notch[4] (Fig. – 1). The soft and flexible lobule of the ear hangs below the antitragus[4].

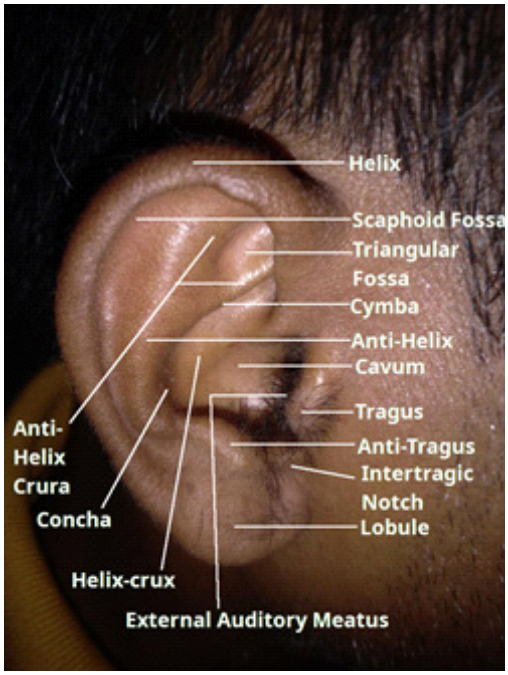


Figure 1: Parts of the External Ear

The auricle is very significant in various religions and cultures, this reflects its anthropological and ethnic importance across populations[5,6]. The ear lobule is of considerable interest in cosmetic and reconstructive practices, including advances in tissue-engineered reconstruction[7].

Studies have shown that external ears exhibit metric variations depending on gender and ethnicity[8,9,10]. Ethnic variations necessitate the availability of population-specific data[11]. Morphometric data of the external ear from other populations is less likely to be applicable to Indians. Few studies on sex determination from ear morphometry in the Indian population are available [12,13]. Studies describing the morphometry of ear auricles in the Indian female population are hardly available [14,15]. One reason for this can be that most of the studies have excluded subjects on the basis of ear piercing[13].

The importance of ear piercing holds social, religious, and aesthetic significance in India. The practice of Karnavedha sanskar, a traditional Hindu ceremony of ear piercing is very rampant[15]. This cultural aspect needs to be considered while studying ear morphometry.

While some authors have employed direct anthropometry[16] , a study conducted in Karnataka employed photogrammetric method to explore sex determination potential using ear morphometry for the Indian population[17]. Since studies based on ear morphometry are sparsely conducted in the adult Bengali population, there is a gap in region-specific anthropometric data. The present study aims to address this issue.

It is expected that the conclusive data will be useful in the fields of forensic science, prosthetics, surgery, anatomy, and even wearable technology[11,16,18,]. Ear morphometric parameters can be utilized during auricular reconstruction surgery[19] and as an adjunct to other methods used for individual human identification [5,11,16].The data from the present study can be utilised to compare previous work related to sexual dimorphism from other countries[20] as well among different ethnic zones of India for demographic and anthropological research [5,18].

Materials and Method

Method--This descriptive cross-sectional study was conducted for a period of one year from March 2021 to March 2022 at the Burdwan Medical College and Hospital (opd)

Ethical Clearance--Ethical approval for the study was obtained from the Institutional Ethics Committee of Burdwan Medical College and Hospital (Ref. No. BMC/I.E.C-077, dated 22.02.2021). Written informed consent was obtained from each participant.

Conflict of interest/ funding-- none

Sample Size---A sample size of 584 ears was calculated based on mean and standard deviation values (Mean: 54.01 mm, SD: 4.69 mm) [5], using the

formula $n = (Z^2 \times SD^2) / d^2$ with a 99% confidence level (z = 2.576) and 0.5 mm precision.

Sampling technique--Simple Random sampling, random numbers were generated using an online randomizer (Randomizer.org).

Inclusion Criteria--1.Healthy adults aged between 18 and 60 years. 2. Permanent residents of Bardhaman district. 3.Willing to provide written informed consent

Exclusion Criteria--1. Individuals with visible congenital deformities of the external ear. 2. History of trauma or surgery affecting the ear. 3. Individuals with ear infections or skin diseases affecting the auricle. 4. Participants refusing consent.

Data Collection and Measurement Techniques--Anthropometric measurements were carried out in a well-lit room with the subject seated comfortably and the head in the Frankfort horizontal plane[21].

Masks, earrings, spectacles were removed, if present. The morphometric parameters were recorded with the subject in a seated position with the head in the Frankfort horizontal plane, using digital vernier calipers (Fig. 2).

To minimise human errors, all the subjects were seated in the same chair, kept in a fixed position and distance from the wall in front. They were asked to focus their gaze at the marked point on the front wall. All the parameters were measured twice for every individual. And all the measurements were taken by the same investigator using the same digital vernier caliper, in the same way, throughout the study duration to eliminate inter-observer variability. All the measurements were taken between 9 AM to 1 PM (OPD hours).

A] The following parameters were measured and collected (independently for right and left side):

i) Auricle length (AL): largest perceived length measured from the uppermost point (on the helix) of the auricle up to the lowest point on the ear lobule.

ii) Auricle width (AW): widest perceived measurement from the attachment (root) of the auricle to maximum convexity of the helix.

iii) Lobule length (LL): the largest distance from the lowest point of free margin of the ear lobule to the line passing through the intertragal notch.

iv) Lobule width (LW): from the line passing through the intertragal notch to outermost maximum transverse width of the ear lobule.

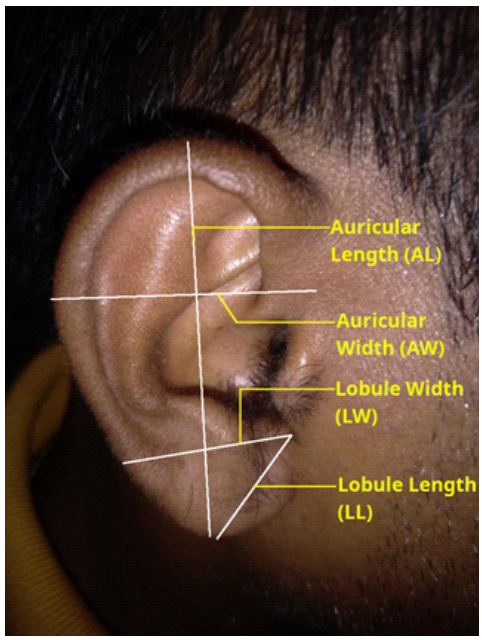


Figure 2: Study Variables measured in this study

b] Auricle index (AI) percentage ratio of width and length of an auricle, and Lobule Index (LI) percentage ratio of width and length of lobule were calculated.

[Auricle Index (AI) = (AW/AL) × 100, Lobule Index (LI) = (LW/LL) × 100]

c] The Mean and Standard deviation of all the variables measured during morphometry of left and right ears of men and women were calculated. Sexual dimorphism was assessed using two-tailed Student's t-test at the 95% confidence interval, comparing right and left ear measurements between the sexes.

d] Data entry and statistical analysis: Microsoft Office 365 Excel.

Results and Analysis

For the sample size of 584 ears, after morphometry, the data was recorded in 2 different tables: Men and Women. The auricular and lobular indices were calculated for men and women. The indices showed the proportions of the auricles and lobes. These tables have been attached in the Master charts.

The Mean and Standard deviations: All the mean and standard deviation values of morphometric variables of Men were found to be greater than Women except for Left Auricle Index which was marginally bigger in women 53.53 +/- 4.33 as compared to men 53.42 +/- 4.5.

Overall Mean Values: Some authors have described the overall mean values of the morphometric variables. In order to compare the data of present study with them, the overall mean values of the corresponding variables of external ears of men and women who participated the study were calculated. VARIABLE and AVERAGE: AL = 59.61, AW = 32.28, LL = 28.57, LW = 25.89, AI = 54.26, LI = 91.02

Right Ear

The t-test and p-values of all the variables of the right ear of men and women were calculated and compared for significance, namely the Right Auricle Length (AL)-9.26, Auricle Width (AW) 9.10, Auricle Index (AI)-1.06, Lobule Length (LL)-4.64, Lobule Width (LW)-7.03 and Lobule Index (LI)-2.47. All the t values and p values were significant except for the Auricle Index (AI) (Table 1). Thus there is a significant difference between all the variables of right ears of men as compared to women except the Auricle Index (AI). (p-value <0.05) (Figure 3)

Table 1: Two tailed paired t-test performed between the corresponding variables of the right ear auricles of Men and Women. (Author's own analysis)

SEX	VARIABLE	t-test	p-value	RESULT
MEN	RT AL	9.26	< .00001	Sig
WOMEN	RT AL			
MEN	RT AW	9.10	< .00001	Sig
WOMEN	RT AW			
MEN	RT LL	4.64	< .00001	Sig
WOMEN	RT LL			
MEN	RT LW	7.03	< .00001	Sig
WOMEN	RT LW			
MEN	RT AI	1.06	0.29	NONSIG
WOMEN	RT AI			
MEN	RT LI	2.47	0.01	Sig
WOMEN	RT LI			

[RT=RIGHT, LT=LEFT, AL=AURICLE LENGTH, AW= AURICLE WIDTH, LL=LOBULE LENGTH, LW=LOBULE WIDTH, AI= AURICLE INDEX,

LI=LOBULE INDEX, SIG=SIGNIFICANT, NONSIG=NONSIGNIFICANT, SD= STANDARD DEVIATION. (p value <0.05)]

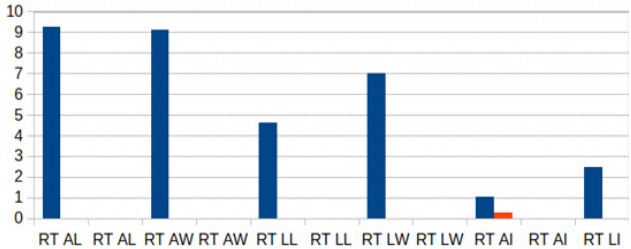


Figure 3: Two-tailed paired t-test results for right ear variables (Author's own analysis)

Left ear

When the variables of the left ears of Men and women were compared using paired, two tailed T test, it was found that the Left Auricle Length (AL)1.09, Auricle Index (AI) -0.78211 and Lobular Index (LI) 0.96 did not show any significant difference. The other values namely, the Left Auricle Width (AW) 7.4, Lobular Length (LL) 2.2, Lobular Width (LW) 2.7 show a significant difference between men and women. (p-value <0.05), (Table 2, Figure 4)

Table 2: Two tailed paired t-test performed between the corresponding variables of the left ear auricles of Men and Women.(Author's own analysis)

SEX	VARIABLE	t-test	p-value	RESULT
MEN	LT AL	1.09	0.28	NONSIG
WOMEN	LT AL			
MEN	LT AW	7.4	< .00001	Sig
WOMEN	LT AW			
MEN	LT LL	2.2	0.03	Sig
WOMEN	LT LL			
MEN	LT LW	2.7	0.01	Sig
WOMEN	LT LW			
MEN	LT AI	-0.78211.	0.43	NONSIG
WOMEN	LT AI			
MEN	LT LI	0.96	0.34	NONSIG
WOMEN	LT LI			

[RT=RIGHT, LT=LEFT, AL=AURICLE LENGTH, AW= AURICLE WIDTH, LL=LOBULE LENGTH, LW=LOBULE WIDTH, AI= AURICLE INDEX, LI=LOBULE INDEX, SIG=SIGNIFICANT, NONSIG=NONSIGNIFICANT, SD= STANDARD DEVIATION. (p-value <0.05)]

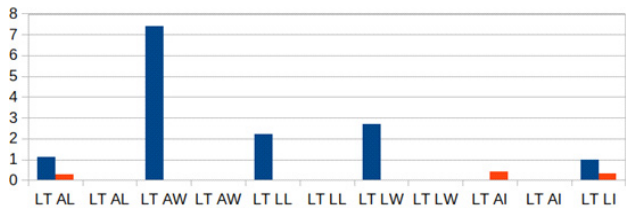


Figure 4: Two-tailed paired t-test results for left ear variables (Author's own analysis)

The present study suggests that significant sexual dimorphism exists in several external ear morphometric parameters among the adult Bengali population (Table 3).

Table 3: Comparative Summary of Right and Left Ear Sexual Dimorphism (Author's own analysis)

SEX	VARIABLE	RIGHT EAR	LEFT EAR
MEN	LT AL	Sig	NONSIG
WOMEN	LT AL		
MEN	LT AW	Sig	Sig
WOMEN	LT AW		
MEN	LT LL	Sig	Sig
WOMEN	LT LL		
MEN	LT LW	Sig	Sig
WOMEN	LT LW		
MEN	LT AI	NONSIG	NONSIG
WOMEN	LT AI		
MEN	LT LI	Sig	NONSIG
WOMEN	LT LI		

Discussion

Brucker et al[22] observed that men had larger auricles than women by 6.5%, whereas lobule dimensions were nearly equal. In the present study, mean auricle length was greater in men than in women, and lobule measurements also showed variation between sexes.

Azaria et al.[23] reported average lobule lengths to be 19.7 mm (SD 4.2) on the left and 20.1 mm (SD 4.2) on the right. In comparison, our study found right and left lobule length in men to be 30.02 mm (SD 3.2) and 28.3 mm (SD 3.07), and in women, 28.39 mm (SD 2.71) and 27.58 mm (SD 2.47), respectively. This suggests that individuals from Bardhaman, West Bengal have longer earlobes than populations in Israel, America, Turkey, Nigeria, and China[6,25–30]. Previous studies have generally reported larger morphometric values in males, a trend that is supported by this study [26].

Some studies utilised direct morphometry with vernier calipers[10, 17], while others preferred indirect method of morphometry [11,18] (photographic methods or 3-D scanning). In this study, digital vernier calipers

were used as a direct method—an easily portable and low-maintenance tool suitable for field research.

According to Purkait and Singh[24] noted that lobule shape and attachment influence its dimensions. Other studies also found that sex and age affect lobular length[26, 27].

Bozkir et al concluded that men had larger height of the pinna than women by 6.5% in the Turkish population[6]. Neimitz[26] et al from Germany and Murgod[17] in Karnataka, India used indirect morphometry and concluded that sexual dimorphism existed among various parameters of the external ear. Maitreyee M also concluded that sexual dimorphism could be seen in all parameters especially, auricle length and width[5]. They also considered auricle attachment and projection, face height and width[5].

In a recent study, Acharya et al. also observed significant sexual dimorphism in external ear morphology in Indian population, which further supports the forensic applicability of ear morphometry[14]. Ekanem et al[27] and Mustapha et al pointed out that sexual dimorphism exists in the Nigerian population[29]. Wang (2010) did not find any significant differences between the ear measurement of males and females[28]. Whereas, the present study begs to differ with Wang, but agrees with the findings of Brucker, Mutalik and with Mustafa that morphometric variables of ear auricles do show sexual dimorphism.

In the 19th century Alphonse Bertillon utilized ear auricle morphometry using his system called as "portrait parlé" [33] or spoken portrait for forensic human identification.

In Brazil, after a prison riot leading to several mangled body parts, a beheaded corpse could not be identified with usual forensic methods. In such situation, ear morphometry can be utilised when other anatomical features are missing for forensic identification[34].

To be useful for identification, biometrics should be constant, unique and easy to acquire in nature[35]. The identification features used so far as biometrics are face and iris scan, fingerprints detection, voice recording and manual signature. During the Covid-19 pandemic, wearing mask was mandatory making identification difficult. The external auricle provides a good source of data for person identification which can be contactless, quick and simple. Ear biometry achieved using simple CCTV camera surveillance (even when mask on) can be used for identification in public places, it does not require cooperation from the subject[36].

Conclusion

The study suggests significant sexual dimorphism in external ear morphometry among the adult Bengali population. However, there was an absence of significant dimorphism in Left Auricle Index and Lobule Index, as compared to their right-sided counterparts. This points toward potential auricular asymmetry, which is a novel and unexpected finding. This not only emphasizes but also highlights the need to include both ears in biometric analyses. Further research is required to establish whether correlation exists between the asymmetry and ethnic, genetic or socioeconomic factors.

Limitations: This study is limited to a specific regional population. As such, the results may not be generalisable to all Indian ethnic groups. The inclusion of individuals with pierced ears may also limit applicability across broader population. In future, meta-analysis targeting diverse Indian populations is recommended. Additional morphometric variables such as conchal width and length, distance between intertragic notch and tragus, the angle of projection of auricle, etc should also be considered. This may provide more precise estimation of sexual dimorphism. Longitudinal studies may help to understand the morphometric changes across different age groups.

Furthermore, the morphology of external ear needs to be correlated with its morphometry. Advanced technology offers faster and more precise resultsas compared to manual morphometry. This point of view is very crucial while comparing data obtained through manual methods versus computer-based morphometry. Nonetheless, the use of handheld vernier calipers is a noninvasive and economical method suitable for carrying out forensic investigations, even in resource-limited settings in remote areas. This study suggests that ear morphometry can be used as a supportive tool during

forensic anthropology, biometric identification and various medico-legal applications. In conclusion, this study shows promising avenues for conducting multi-ethnic, ear morphometry based studies incorporating 3D scanning for accurate and reliable ear based human identification.

Acknowledgment: The author expresses her gratitude to the head of the department, faculty and staff of the Department of Anatomy, Burdwan Medical College, for their support during the research work. Heartfelt appreciation is also extended to all the participants who generously gave their consent to be part of the study.

Source of funds: Self.

Conflict of interest: Nil

Ethical clearance: Obtained from Institutional Ethics Committee, Burdwan Medical College, Purba Bardhaman, West Bengal. Memo no.BMC/IEC/077 Dated- 22nd Feb 2021.

References

1. Merriam-Webster. Ear [Internet]. Merriam-Webster. com; 2025 [cited 2025 Jul 8]. Available from: https:// www.merriam- webster.com/dictionary/ear
2. Datta AK. Essentials of human anatomy: head and neck. Kolkata: Current Books International; p. 317–46.
3. Gleeson M. External and middle ear. In: Standring S, editor. Gray's anatomy: the anatomical basis of clinical practice. 41st ed. London: Elsevier; 2015. p. 624–39.
4. Singh V. Textbook of anatomy: head, neck, and brain. Vol. 3. 2nd ed. New Delhi: Elsevier; p. 252–72.
5. Maitreyee M. Analysis of morphometric and somatoscopic traits of auricle of ear in India: relation with diversified ethnicities. J Exp Clin Anat. 2019;18(1):1.
6. Bozkır MG, Karakaş P, Yavuz M, Dere F. Morphometry of the external ear in our adult population. Aesth Plast Surg. 2006;30(1):81–5.
7. Cao Y, Vacanti JP, Paige KT, Upton J, Vacanti CA. Transplantation of chondrocytes utilizing a polymer-cell construct to produce tissue-engineered cartilage in the shape of a human ear. Plast Reconstr Surg. 1997;100(2):297–302.
8. Pupovac N, Knežić N. Morphometry of the auricle. Medicina Danas. 2017;16(7–9):117–23.
9. Mohamed H, Adly M, Abuelhamed M. Determination of Sex in Minia Government using External Ear Print Measurements [Internet]. 2018 Jul 5 [cited 2025 Jul 9]. Available from: https://www.researchgate.net/ publication/326200334_ Determination_of_Sex_in_ Minia_Government_using_ External_Ear_Print_ Measurements
10. Kumar BS, Selvi GP. Morphometry of ear pinna in sex determination. Int J Anat Res. 2016;4(2):2480–4.
11. Britto J, Panchal P, Prasad A, Kumari R, Kumari S. Photogrammetric morphometric analysis of auricle. Int J Med Sci Public Health. 2018 Jun 1;7(6):440-3.
12. Sharma A, Sidhu NK, Sharma MK, Kapoor K, Singh B. Morphometric study of ear lobule in northwest Indian male subjects. Anat Sci Int. 2007;82(2):98–104.
13. Verma P, Sandhu HK, Verma KG, Goyal S, Sudan M, Ladgotra A. Morphological variations and biometrics of ear: an aid to personal identification. J Clin Diagn Res. 2016;10(5):ZC138.
14. Acharya S, Gupta C, Palimar V, Kalthur SG, Adhikari P. Morphology and morphometry of human external ear with its significance in sex determination and stature estimation: an observational study. F1000Res. 2025;14:119.
15. Dattatraya JS. Study of Karnavedhana: ancient and contemporary methods. Int Ayurvedic Med J. 2021;9(5):947–51.
16. Purkait R. Progression of growth in the external ear from birth to maturity: a 2-year follow-up study in India. Aesth Plast Surg. 2013;37(3):605–16.
17. Murgod V, Angadi P, Hallikerimath S, Kale A. Anthropometric study of the external ear and its applicability in sex identification: assessed in an Indian sample. Aust J Forensic Sci. 2013;45(4):431–44.
18. Kala AC, Rajoria S, Agarwal CK, Raj S. Comparative assessment of external ear: morphometric study and sexual dimorphism in medical students in SMS Medical College, Jaipur. J Med Sci Clin Res. 2019;7(5):7406–10.
19. Jagriti R, Raju. Morphometric analysis of the human ear, examining its sexual dimorphism in medical students. Med Innov. 2023;12(2):58–62.
20. Sezgin N, Ersoy G. Metric and morphological features of the ear in sex classification. Egypt J Forensic Sci. 2023;13:44.
21. Richards J. What is the Frankfort plane? [Internet]. NutriActiva Blog; 2024 [cited 2025 May 27]. Available from: https://nutriactiva.com/blogs/ anthropometry/ what-is-the-frankfort-plane

22. Brucker MJ, Patel J, Sullivan PK. A morphometric study of the external ear: age- and sex-related differences. Plast Reconstr Surg. 2003;112(2):647–52.
23. Azaria R, Adler N, Silfen R, Regev D, Hauben DJ. Morphometry of the adult human earlobe: a study of 547 subjects and clinical application. Plast Reconstr Surg. 2003;111(7):2398–402.
24. Purkait R, Singh P. Anthropometry of the normal human auricle: a study of adult Indian men. Aesth Plast Surg. 2007;31(4):372–9.
25. Elyasi L, Araban S, Eftekhar Vaghefi SH. Auricle morphometry in Iranian population. Anat Sci J. 2020;17(2):47–54.
26. Niemitz C, Nibbrig M, Zacher V. Human ears grow throughout the entire lifetime according to complicated and sexually dimorphic patterns: conclusions from a cross-sectional analysis. Anthropol Anz. 2007;65(4):391–413.
27. Ekanem AU, Garba SH, Musa TS, Dare ND. Anthropometric study of the pinna (auricle) among adult Nigerians resident in Maiduguri metropolis. J Med Sci. 2010;10(6):176–80.
28. Wang B, Dong Y, Zhao Y, Bai S, Wu G. Computed tomography measurement of the auricle in Han population of north China. J Plast Reconstr Aesthet Surg. 2011;64(1):34–40.
29. Mustapha M, Firdausi Y, Miko A. Sex discrimination potential of morphometric ear variables among Hausa adolescents in Zaria, Northwestern Nigeria. Niger J Sci Res. 2016;15(3):63–7.
30. Alexander KS, Stott DJ, Sivakumar B, Kang N. A morphometric study of the human ear. J Plast Reconstr Aesthet Surg. 2011;64(1):41–7.
31. Nyemb PMM, Sankale AA, Ndiaye L, Ndiaye A, Gaye M. Morphometric study of the outer ear in young adults. Pan Afr Med J. 2014;19:355.
32. Fakorede ST, Adekoya KO, Fasakin TP, Odufisan JO, Oboh B. Ear morphology and morphometry as potential forensic tools for identification of the Hausa, Igbo and Yoruba populations of Nigeria. Bull Natl Res Cent. 2021;45(1):205.
33. Bertillon A. Identification anthropométrique: instructions signalétiques [Internet]. Melun: Imprimerie administrative; 1893 [cited 2025 Jul 8]. Available from: http://archive.org/details/identificationa00bertgoog
34. Carvalho GP, Bantim YCV. Inmates beheaded in a Brazil prison riot: human identification by ear individual signs. J Forensic Leg Med. 2019;68:101870.
35. Thales Group. Biometrics: definition, use cases, latest news [Internet]. 2023 [cited 2025 May 28]. Available from: https://www.thalesgroup.com/en/markets/digital-identity-and-security/government/inspired/biometrics
36. Ahila Priyadharshini R, Arivazhagan S, Arun M. A deep learning approach for person identification using ear biometrics. Appl Intell. 2021;51(4):2161–72.

Original Article

DOI: https://doi.org/10.37506/qtj1ea77

A Demographic and Forensic Analysis of Thermal Burn Fatalities: An Autopsy-Based Study in Kolhapur District

N.S. Jagtap[1], M.M. Ghatage[2], Y.S. Thorat[3]

[1]Assistant Professor, Department of Forensic Medicine & Toxicology, R.C.S.M. Government Medical College & CPR Hospital Kolhapur, [2]Assistant Professor, Department of Forensic Medicine & Toxicology, R.C.S.M. Government Medical College & CPR Hospital Kolhapur, [3]Assistant Professor, Department of Forensic Medicine & Toxicology, Government Medical College Miraj.

How to cite this article: N.S. Jagtap, M.M. Ghatage, Y.S. Thorat. A Demographic and Forensic Analysis of Thermal Burn Fatalities: An Autopsy-Based Study in Kolhapur District. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

Background: Thermal burns remain a major public health concern in developing countries, with significant mortality and medico-legal implications. Regional studies are essential for understanding the unique demographic and forensic patterns that influence outcomes.

Objective: To analyze the demographic profile, manner of death, extent of burns, and survival patterns among thermal burn victims subjected to medicolegal autopsy in Kolhapur district.

Methods: A retrospective observational study was conducted over a defined period, examining 475 autopsy cases of thermal burn deaths at a tertiary healthcare center in Kolhapur district. Data were analyzed for age, sex, total body surface area (TBSA) involved, manner of death, survival duration, seasonal trends, and urban-rural distribution.

Results: Out of 475 cases, females accounted for 63.7% of burn deaths. The most affected age group was 21–30 years (31.7%). Accidental burns were the predominant manner of death (73.9%). TBSA involvement >80% was observed in 48% of cases. A majority of deaths occurred within 1–3 days post-injury. Rural areas and winter season showed a higher incidence.

Conclusion: The study highlights a high prevalence of thermal burn deaths among young rural females in Kolhapur, often with extensive TBSA involvement and limited survival duration. These findings underscore the urgent need for improved burn prevention strategies, timely medical care, and region-specific public health interventions.

Keywords: Thermal burns, Burn mortality, Autopsy study, Forensic pathology, Kolhapur district, Demographic profile, TBSA, Accidental burns, India, Medicolegal autopsy

Corresponding Author: N.S.Jagtap, Assistant Professor, Department of Forensic Medicine & Toxicology, R.C.S.M. Government Medical College & CPR Hospital Kolhapur.

E-mail: nikhiljagtap13.nj@gmail.com

Submission date: July 31, 2025 **Acceptance date:** Sept 3, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

Introduction

Burn injuries represent one of the most devastating forms of trauma, often resulting in significant morbidity and mortality worldwide. They remain a major public health issue, especially in low- and middle-income countries where access to specialized burn care is often limited[1,2]. Globally, an estimated 180,000 deaths annually are attributed to burns, with the vast majority occurring in developing nations[3]. India, in particular, accounts for a substantial proportion of global burn mortality, with studies indicating over 700,000 burn injuries annually and an estimated 1,40,000 deaths[4,5].

Thermal burns can result from various sources such as flame, scalds, contact with hot objects, and explosions. Among these, flame burns are most commonly associated with fatal outcomes[6,7]. Burn injuries in India have unique epidemiological and socio-cultural patterns, with young women being disproportionately affected, often in the context of domestic accidents, suicides, or dowry-related violence[8-10]. The age group of 21–30 years is consistently reported as the most vulnerable demographic, likely due to increased domestic exposure and social pressures[11,12].

Autopsy-based studies play a crucial role in understanding the pattern, cause, and manner of burn-related deaths. These studies help determine whether the death was accidental, suicidal, or homicidal, and are essential for medico-legal investigations and prevention strategies[13.14]. The integration of forensic findings with epidemiological data can guide public health interventions aimed at reducing burn mortality and improving outcomes for burn victims[15].

Despite the high burden, literature on the demographic profiling and forensic autopsy findings of burn deaths remains limited in many regions. Available studies have pointed toward significant gender disparities, seasonal variations, and urban-rural differences in incidence[16-18]. Furthermore, social determinants such as education, occupation, and housing conditions influence both the occurrence and outcome of burn injuries.[19-21].

This study aims to fill the knowledge gap by analyzing the demographic characteristics and autopsy findings of thermal burn fatalities over a defined period. It seeks to identify key risk groups and patterns, and to propose evidence-based preventive measures. Through this, the study contributes to the larger goal of reducing avoidable deaths from thermal injuries and improving forensic understanding in burn-related fatalities.[22,23].

Methodology

Study Design: The study was conducted in the Department of Forensic Medicine and Toxicology, Rajarashi Chhatrapati Shahu Maharaj Government Medical College Kolhapur District, MaharashtraThe study included all autopsy cases of thermal burn fatalities brought for medico-legal examination during this time.

Study Period: January 1, 2021 to December 31, 2023.

Inclusion Criteria:

- All deceased individuals subjected to medico-legal autopsy with a cause of death determined to be thermal burns.
- Cases with complete autopsy records, including police inquest reports, hospital treatment records (if available), and postmortem findings.

Exclusion Criteria:

- Cases of electrical burns, chemical burns, or scalds without flame burns.
- Decomposed bodies where the cause of death could not be reliably ascertained.
- Incomplete documentation or missing case files.

Assessment of Burn Extent: The extent of burn injury was calculated using the Wallace Rule of Nines. Where available, hospital-based TBSA estimations were cross-checked with autopsy documentation.

Results

A total of 475 autopsy cases of thermal burn fatalities were included in the study conducted over the specified period.

1. Gender Distribution

Out of 475 cases, 303 (63.7%) were females and 172 (36.3%) were males, showing a marked female predominance.

Table 1: Gender-wise Distribution of Burn Cases

Gender	Number of Cases	Percentage (%)
Male	172	36.2%
Female	303	63.7%
Total	475	100%

2. Age-wise Distribution

Burn deaths were most common in the 21–30 years age group (151 cases, 31.7%), followed by:

- 0–10 years: 26 cases (5.4%)
- 11–20 years: 102 cases (21.4%)
- 31–40 years: 89 cases (18.7%)
- 41–50 years: 60 cases (12.6%)
- 51–60 years: 29 cases (6.1%)
- 60 years: 18 cases (3.7%)

Table 2: Age-wise Distribution of Burn Cases

Age Group (Years)	Number of Cases	Percentage (%)
0–10	26	5.4%
11–20	102	21.4%
21–30	151	31.7%
31–40	89	18.7%
41–50	60	12.6%
51–60	29	6.1%
>60	18	3.7%
Total	475	100%

3. Manner of Death

The majority of deaths were accidental in nature (205 cases, 73.9%), followed by:

- Suicidal burns: 56 cases (20.2%)
- Homicidal burns: 16 cases (5.7%)

Table 3: Manner of Death in Burn Cases

Manner of Death	Number of Cases	Percentage (%)
Accidental	205	73.9%
Suicidal	56	20.2%
Homicidal	16	5.7%
Total	277	100%

4. Extent of Burns (Total Body Surface Area - TBSA)

- 80% TBSA: 228 cases (48%)
- 51–80% TBSA: 162 cases (34.1%)
- 31–50% TBSA: 53 cases (11.2%)
- ≤30% TBSA: 32 cases (6.7%)

4: Extent of Burns (Total Body Surface Area – TBSA)

TBSA (%)	Number of Cases	Percentage (%)
≤30%	32	6.7%
31–50%	53	11.2%
51–80%	162	34.1%
>80%	228	48.0%
Total	475	100%

5. Duration of Survival Post-Burn

- Died within 24 hours: 141 cases (29.6%)
- Survived 1–3 days: 169 cases (35.5%)
- Survived >3 days: 165 cases (34.7%)

Table 5: Survival Time Post-Burn

Survival Duration	Number of Cases	Percentage (%)
<1 day	141	29.6%
1–3 days	169	35.5%
>3 days	165	34.7%
Total	475	100%

6. Urban vs Rural Distribution

- Rural cases: 287 (60.4%)
- Urban cases: 188 (39.6%)

Table 6: Seasonal Distribution of Burn Cases

Season	Number of Cases	Percentage (%)
Winter	183	38.5%
Summer	147	30.9%
Monsoon	145	30.5%
Total	475	100%

7. Seasonal Variation

The highest incidence was observed during the winter season (November–January) with 183 cases (38.5%), followed by:

- Summer (March–June): 147 cases (30.9%)
- Monsoon (July–October): 145 cases (30.5%)

Table 7: Urban vs Rural Distribution

Area Type	Number of Cases	Percentage (%)
Urban	188	39.6%
Rural	287	60.4%
Total	475	100%

8. Autopsy Findings

Common autopsy findings included:

- Pugilistic attitude: 411 cases (86.5%)
- Singeing of scalp hair: 398 cases (83.8%)
- Soot in trachea/bronchi: 264 cases (55.5%)
- Congestion of lungs: 379 cases (79.8%)
- Visceral congestion (liver, spleen, kidneys): Present in 401 cases (84.4%)
- Subendocardial hemorrhage: Observed in 139 cases (29.2%)

Table 8: Autopsy Findings in Thermal Burn Fatalities (n = 475)

Autopsy Findings	Number of Cases	Percentage (%)
Pugilistic attitude (boxing posture)	411	86.5%
Singeing of scalp hair	398	83.8%
Soot particles in trachea/bronchi	264	55.5%
Congestion of lungs	379	79.8%
Visceral congestion (liver, spleen, kidneys)	401	84.4%
Subendocardial haemorrhage	139	29.2%

Discussion

Burn injuries remain a significant public health concern, particularly in low- and middle-income countries like India, where they constitute a major share of medico-legal autopsy cases. The present study analyzed 475 cases of thermal burn deaths to evaluate demographic trends, patterns of injury, and associated autopsy findings.

In our study, females accounted for 63.7% of the total burn fatalities, which is consistent with findings from Sharma et al. (2002), who reported a female predominance of 65% in burn deaths in North India[4]. Similarly, Kumar et al. (2007) observed that 60.2% of burn deaths were among females, attributing it to domestic exposure, traditional cooking practices, and sociocultural factors like dowry harassment and marital disputes[12]. This gender disparity underscores the vulnerability of women, particularly in the domestic setting.

The 21–30 years age group was the most affected (31.7%) in our series, similar to the observations of Subrahmanyam (1996), who found that young adults in the second and third decades of life were at the highest risk[6]. This age group corresponds with increased domestic responsibilities and exposure to open flames, kerosene stoves, and cooking fires, especially among females.

The majority of the cases (73.9%) were accidental, which aligns with findings from studies by Singh et al. (1996) and Behera et al. (2008), where accidental burns were reported in 70–75% of cases[9,17]. However, 20.2% of deaths were suicidal, and 5.7% were homicidal, reflecting the continued relevance of burn injuries in self-harm and criminal acts. Mohanty and Panigrahi (2004) also highlighted the growing incidence of suicidal burns among young married women, often related to dowry or domestic abuse[20].

Burn extent analysis revealed that 48% of victims had >80% TBSA involvement. Similar findings were reported by Pal et al. (1997), where more than half of the burn fatalities had TBSA >70%[10]. High TBSA is strongly associated with poor prognosis due to fluid loss, infection, and systemic organ failure. Singh et al. (2003) noted that patients with burns exceeding 60% TBSA rarely survive without prompt and intensive care[16].

In terms of survival period, 34.7% of the victims survived more than 3 days, suggesting possible opportunities for medical intervention in some cases. Ganesan et al. (2020) reported similar findings, emphasizing that early hospitalization and resuscitation could reduce mortality, especially in patients with 40–60% TBSA burns[23].

Seasonal variation showed a peak during the winter season (38.5%), which is likely due to the increased use of heating appliances, open fires, and indoor cooking during colder months. This is in concordance with studies by Lal and Chavan (2013), who also reported a winter predominance in burn incidents[7].

Autopsy findings in this study provide valuable insight into the pathophysiology of burn-related deaths. The pugilistic attitude (seen in 86.5% of cases) is a common feature of thermal burns due to muscle contraction from intense heat[14]. Singeing of hair and soot in the tracheobronchial tree were seen in 83.8% and 55.5% of cases, respectively, indicating exposure to flame and inhalation of smoke prior to death. Similar findings were highlighted in studies by Dogra and Rudra (2000), where soot in airways was considered a reliable marker of antemortem burning[8].

Visceral congestion and subendocardial hemorrhages were also frequently observed, supporting the systemic inflammatory response and hypoxia as contributing factors in burn mortality[13]. These pathological findings are in agreement with the observations of Reddy (2017) and Hemalatha & Kumar (2014), who emphasized the importance of internal examination in ascertaining the vitality of burns[15,21].

Our study also noted a higher number of cases from rural areas (60.4%), likely reflecting poor access to safe cooking practices, emergency care, and health education. This rural predominance has also been reported in studies by Chawla et al. (2013) and Ahuja & Bhattacharya (2004), stressing the need for targeted community-based prevention strategies[18,19].

Overall, this study reinforces the role of forensic autopsy in identifying patterns and potential preventive strategies for burn fatalities. The demographic trends, especially among young females, highlight urgent social and public health priorities.

Uniqueness of the Study in Kolhapur District

This study is one of the few comprehensive forensic analyses of thermal burn fatalities specifically conducted in the Kolhapur district of Maharashtra, a region with distinct sociocultural and geographic characteristics. Unlike larger metropolitan studies, this research provides valuable insight into the rural-urban divide, with a majority of cases originating from rural backgrounds where traditional cooking methods, poor housing conditions, and limited access to emergency care are prevalent. Kolhapur's cold winters, reliance on open flames, and high prevalence of kerosene-based cooking further contribute to burn incidents, which are contextually different from other regions. The study also highlights local trends in dowry-relatedsuicides and domestic accidents, which remain underreported elsewhere. By correlating demographic patterns with autopsy findings over a defined period, the study offers a region-specific evidence base that can inform targeted public health interventions and legal reforms in the Kolhapur district.

Conclusion

Thermal burns continue to be a significant cause of mortality, especially in developing regions like ours. This study revealed that burn fatalities predominantly affect young females in the reproductive age group, reflecting the social and domestic vulnerabilities they face. Accidental burns were the most common manner of death, with high total body surface area (TBSA) involvement contributing to poor prognosis and high mortality. A significant number of victims survived for more than 24 hours, highlighting the need for timely and advanced medical care.

Seasonal peaks during the winter and a higher incidence in rural areas emphasize the influence of environmental and socioeconomic factors. The autopsy findings not only confirmed the cause and manner of death but also helped in differentiating between antemortem and postmortem burns, contributing to the medico-legal understanding of these cases.

This study underscores the need for improved public education, safe cooking practices, and better access to burn care facilities, and stronger enforcement of domestic safety laws. Multisectoral intervention—combining medical, legal, and social approaches—is essential to reduce the burden of burn-related mortality in the population.

Future Research Recommendations

1. **Prospective multicentric studies** – Conducting prospective studies across multiple districts or states to compare regional variations in burn epidemiology and autopsy findings.
2. **Integration of forensic and clinical data** – Combining autopsy results with hospital admission records to assess the role of pre-hospital care, resuscitation, and treatment outcomes in survival rates.
3. **Socioeconomic and cultural factors** – Investigating the influence of literacy levels, occupational hazards, domestic fuel use, and cultural practices on burn incidence.
4. **Burn injury prevention programs** – Evaluating the effectiveness of community-based burn awareness campaigns, safety regulations, and public health interventions.
5. **Histopathological correlation studies** – Expanding microscopic examination of burn tissue to better determine vitality, duration of survival, and possible inhalation injury effects.
6. **Toxicological analysis** – Including routine screening for carbon monoxide, cyanide, and alcohol to assess their contribution to mortality in burn victims.
7. **Longitudinal follow-up studies** – Tracking survivors of severe burns to understand long-term morbidity, psychological effects, and socio-economic impact.

Limitations of the Study

1. **Hospital-based autopsy data** – The study is based solely on medicolegal autopsy cases, which may not represent all burn-related deaths in the community, particularly those not reported for postmortem examination.
2. **Retrospective design** – Being retrospective, the study relied on available records, which may have incomplete or missing details regarding scene findings or pre-hospital treatment.
3. **Limited clinical correlation** – Information on pre-burn medical conditions, hospital course, and treatment interventions was not uniformly available, limiting clinicopathological correlation.
4. **Geographic restriction** – Findings are specific to the Kolhapur district and may not be generalizable to other regions with different sociocultural and healthcare contexts.
5. **Potential bias in cause classification** – Manner of death (accidental, suicidal, homicidal) was determined based on police inquest and case history, which may be influenced by reporting bias.

Declarations

Ethics approval and consent to participate and consent: Not Applicable since the study did not include any intervention of live subjects

Funding and conflicts of interest: None to declare

References

1. Peck MD. Epidemiology of burns throughout the world. Part I: Distribution and risk factors. *Burns*. 2011;37(7):1087–100.
2. Forjuoh SN. Burns in low- and middle-income countries: a review of available literature on descriptive epidemiology, risk factors, treatment, and prevention. *Burns*. 2006;32(5):529–37.
3. World Health Organization. Burns Fact Sheet. Geneva: WHO; 2018.
4. Sharma BR, Harish D, Sharma A, Sharma S. Kitchen accidents vis-à-vis dowry deaths. *Burns*. 2002;28(3):250–3.
5. Gupta M, Gupta OK, Goil P. Burn epidemiology: the Pink City scene. *Burns*. 1993;19(1):47–51.
6. Subrahmanyam M. Epidemiology of burn injuries—A study of 1239 patients. *Burns*. 1996;22(6):433–7.
7. Lal S, Chavan KD. Pattern of fatal burns in Aurangabad, Maharashtra: a postmortem study. *J Forensic Med Toxicol*. 2013;30(1):45–8.
8. Dogra TD, Rudra A. Fire deaths in Delhi: a study of 200 cases. *Forensic Sci Int*. 2000;110(2):149–57.
9. Singh D, Jit I, Tyagi S. Burn deaths in Chandigarh zone: an autopsy study. *Am J Forensic Med Pathol*. 1996;17(4):312–5.
10. Pal J, Bhatnagar A, Agarwal P. Epidemiological and socio-cultural study of burn patients in M.Y. Hospital, Indore, India. *Burns*. 1997;23(6):420–3.
11. Patetta MJ. Fire-related deaths and injuries in residential structures. *JAMA*. 1990;263(2):214–6.

12. Kumar A, Lalwani S, Sharma A, Rautji R, Dogra TD. Fatal burns in Delhi, India: a retrospective epidemiological study. *J Burn Care Res*. 2007;28(1):115–9.
13. Gautham K, Agnihotri AK. Pattern and distribution of fatal burn injuries: a medico-legal study. *J Indian Acad Forensic Med*. 2011;33(4):312–6.
14. Reddy KSN. *The Essentials of Forensic Medicine and Toxicology*. 34th ed. Hyderabad: K Suguna Devi; 2017.
15. Hemalatha V, Kumar A. Forensic evaluation of burn deaths—A study of 100 cases. *Indian J Forensic Med Pathol*. 2014;7(3):117–20.
16. Singh H, Singh A, Gorea RK, Aggarwal AD. Burns mortality in Chandigarh zone. *J Indian Acad Forensic Med*. 2003;25(3):133–9.
17. Behera C, Rautji R, Dogra TD. Burn injuries: An analysis of 500 patients. *Medico-Legal Update*. 2008;8(2):33–6.
18. Chawla R, Chanana A, Rai H. Burn injury profile: a study from a tertiary care hospital in northern India. *J Clin Diagn Res*. 2013;7(2):250–3.
19. Ahuja RB, Bhattacharya S. ABC of burns: Burns in the developing world and burn disasters. *BMJ*. 2004;329(7463):447–9.
20. Mohanty S, Panigrahi MK. Deaths due to burns in a developing country: are women still the victims? *J Clin Forensic Med*. 2004;11(4):250–2.
21. Mehta M, Shahane S. Burn mortality in India: a study of 1000 cases. *Int J Burns Trauma*. 2012;2(3):112–6.
22. Sharma S, Gupta A, Singh S. Epidemiology and outcomes of burn injuries in a tertiary care center: a 5-year study. *Indian J Plast Surg*. 2020;53(1):38–44.
23. Ganesan M, Jha AK, Subbiah M. Mortality predictors in flame burns: a prospective analysis. *Indian J Crit Care Med*. 2020;24(4):256–61.

Original Article

DOI: https://doi.org/10.37506/1xvnd367

An Analysis on the Pattern and Distribution of Fatal Injuries Among Homicidal Deaths in Kalaburagi: An Autopsy Based Study.

Umesh SR[1], Parvathy Jayapal[2], Deepak Suntnoore[3], Maqdoom SyedSyed Musab[4]

[1]Dean and Director, Professor, [2]Senior Resident, [3]Assistant Professor,[4]Student, Department of Forensic Medicine and Toxicology, ESIC Medical College and Hospital, Kalaburagi.

How to cite this article: Parvathy Jayapal. An Analysis on the Pattern and Distribution of Fatal Injuries Among Homicidal Deaths in Kalaburagi: An Autopsy Based Study. Indian Journal of Forensic Medicine and Toxicology/ Volume 19 No. 4, October-December 2025.

Abstract

Introduction: Homicide is the act of one person intentionally or negligently causing the death of another. Homicide affects communities by instilling fear, shaping legal policies, and influencing societal perceptions of violence The study of pattern and distribution offatal injuries in homicide helps us to reconstruct events and identify perpetrators. Strategies aimed at reducing homicide rates, improving justice systems, and supporting victims' families should be developed.

Materials and Methods: This is a prospective cross- sectional study of eighteen months duration**.** Out of 1293 cases autopsied during this study period, there were 70 (5.41%) cases of homicide. In the 70 homicidal cases, 60 cases (85.71%) fulfilling our inclusion criteria was included in the study.

Results: Laceration was the most common individual fatal injury observed in our study, in 26 cases (21.13%), apart from fractures in 45 cases. Head was the most common area affected in the majority of victims (in 27 cases). The least affected were abdomen and lower limbs.

Conclusion: Homicide is one of the most serious crimes, affecting individuals, families, and communities in profound ways. The consequences extend beyond the victim and perpetrator, influencing social structures, public policies, and emotional well-being. A study on homicide is essential for understanding the nature of violent crime, can help with the investigation and for preventing future incidents.

Keywords: homicide, laceration, fatal injuries

Introduction

According to United Nations's 'Global Study on Homicide', homicide is defined as the intentional act of taking another person's life, not including killings that occur within warfare and other such conflicts. One of the earliest studies conducted on the psychology of homicide, has defined criminal homicide as a collective transaction, in which an offender, victim and possibly an audience engage in an interchange which leaves the victim dead, but

Corresponding Author: Parvathy Jayapal, Senior Resident, Department of Forensic Medicine and Toxicology, ESIC Medical College and Hospital, Kalaburagi.

E-mail: parvathyathul21@gmail.com

Submission date: June 4, 2025 **Acceptance date:** July 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

how these transactions were at times organized and not so in other cases remains a puzzle.[1]

Historically, motives for murder have often centered around desires for money, power, or land. To commit a murder, two key elements must be present: "mens rea" (the intention or premeditation) and "actus reus" (the actual execution of the crime).[2]

The detailed analysis and interpretation of autopsy findings are essential for reconstructing the crime scene. Autopsy surgeons play a critical role in determining the cause of death, understanding the methods and means of the crime, and detailing the inflicted injuries. This information helps in framing charges and determining appropriate punishments. Examining the nature of wounds and the weapon used is key to identifying the charges and subsequent penalties for the accused.[3]

The increase in the incidence of homicide can be attributed to several factors, including rapid population growth, industrialization, globalization, rising unemployment, and the stressful nature of modern life. Additional contributors include widespread depression, familial discord, drug addiction, and socio-political issues.[4]

According to Crime in India 2022 (statistics volume 1) published by the National Crime Records Bureau Ministry of Home Affairs-A total of 28,522 cases of murder were registered during 2022, showing a marginal decline of 2.6% over 2021 (29,272 cases). 'Disputes' (9,962 cases) was the motive in highest number of murder cases during 2022 followed by 'Personal vendetta or enmity' (3,761 cases) and 'Gain' (1,884 cases). The rate of murder in the state of Karnataka is 2.1 while that of its neighbouring state of Maharashtra is 1.8, Andhra Pradesh 1.7, Kerala 0.9.[5]

According to Crime in Karnataka 2021 report, a total of 1357 cases of murder were registered during 2021, showing an increase of 1.95% over 2020 (26 cases)."Dispute" (531 cases) was the motive in highest number of murder cases during 2021 followed by personal vendetta or enmity (341 cases) and illicit relationship (152 cases). In 2021, the rate of murder in Kalaburagi was 2.0 and that of Kalaburagi City was 3.9, as compared to 1.5 of Raichur, 2.1 of Bidar and 1.2 of Bellari. When 40, 41, 36 murder cases were reported in Bellari, Bidar and Raichur respectively, Kalaburagi and Kalaburagi City reported 41 and 39 cases respectively. In 2020 the number of murder cases reported in Kalaburagi was 38 and in Kalaburagi city was 27.[6]

In view of the increasing number of homicidal deaths and its impact on our society, a study on homicidal deaths-its pattern and distribution of fatal injuries, is the need of the hour. It will not only help in connecting the victim to the object or weapon causing the injury, the analysis of the type, location and severity of wounds will also help to reconstruct the events surrounding the death. This would help the investigating authorities in their investigation to piece together the circumstances surrounding the crime.

Material & Methods

The present prospective cross-sectional study is conducted at Gulbarga Institute of Medical Sciences for a period of 18 months, from July 2022 to December 2023. The approval and clearance from the institutional research and ethics committee (ref no. GIMS/GLB/PHARMA/IEC/106/2022-23, dated:18-07-2022)was obtained prior to starting of the study. Convenience sampling technique was used to collect the samples. A total of 60 homicidal cases, fulfilling the inclusion criteria were included in the study. The data collected were entered in the performa, prepared for the study. All the data that were collected were put into charts, analysis was done using mean, percentage, standard deviation. Tables and figures were prepared with Microsoft Excel.

Inclusion criteria:

- All the cases with alleged history of homicide brought to the mortuary of Gulbarga Institute of Medical Sciences, Kalaburagi, for medico legal autopsy by the investigating officer.
- All cases with alleged history of suicide, accident or natural death, but which were later converted to homicide based on autopsy findings and further investigations by the police officers.

Exclusion criteria

- Deaths due to poisoning, asphyxial deaths and burns.

- Bodies found in advanced stages of decomposition.
- Cases of infanticides.
- Custodial deaths

Assessment tools:

Autopsy instruments, measuring tape, weighing machines, photographs.

Statistical Analysis:

The information was collected from the police, inquest reports, hospital records and after postmortem examinations. It was then entered in Microsoft Excel 2019 sheet and the data collected were analysed statistically using SPSS20 software, windows10. Data is presented as frequency and percentage.

Results

Out of 1293 cases autopsied during the 18 months study period, there were 70 (5.41%) cases of homicide. In the70 homicidal cases, 60 cases (85.71%) were due to mechanical injuries and 10 cases were excluded, as they were falling into our exclusion criteria.

Table no. 1: Total number of autopsies conducted

Autopsy conducted	No.	Percentage
Homicidal cases	70	5.41%
Others	1223	94.59%
Total	1293	100%



Fig No.1: Representation of total autopsy conducted

Table no. 2: Total number of homicidal cases

Homicidal cases	No.	Percentage
Due to mechanical injuries	60	4.64%
Others (excluded cases)	10	0.77%
Total	70	5.41%

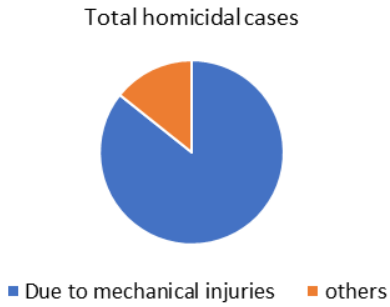


Fig No.2: Representation of total homicidal cases.

Pattern/ Type of fatal injuries

70% (42 cases) of victims had single type of injury. This also included victims with surgical sutured wounds (who had undergone surgery after the incident) which were present in 11 cases. Onanalysis of surgical sutured wounds, 8 were lacerated wounds, 2 were stab wounds and one involved fracture neck of femur. 3 cases (5%) presented with internal contusion and bleeding, without any obvious external injury. Multiple type of fatal injuries were seen in 18 cases (30%). Two types of fatal injuries were seen in 15 cases and 3 type of fatal injuries were seen in 03 cases. Laceration was the most common individual injury observed in our study in 26 cases (21.13%), apart from fractures in 45 cases. It was followed by contusion (17.06%) and stab injuries (12.19%). The least frequent injury was crush injury (2.43 %).

Table No. 3: Fatal injuries.

Fatal injuries	No.	Percentage
Cases with single fatal injury	42	70%
Cases with multiple fatal injuries	18	30%
Total	60	100%

Table No. 4: Cases with single type of injury

Cases with single type of injury	No.
Contusion	14
Stab wound	11
Chop wound	3
Laceration	13
Cut throat wound	0
Incised wound	0
Crush injury	0
Fractures	1
Total	42

Table No. 5: Cases with two types of injuries

Cases with two types of fatal injuries	No.
Laceration + contusion	5
Laceration + incised	3
Laceration + cut throat injury	2
Laceration + stab	1
Stab + chop	1
Stab + cut throat	1
Crush injury + contusion	2
Total	15

Table No. 6: Cases with three types of injuries

Cases with three types of fatal injuries	No.
Laceration + stab + chop wound	1
Laceration + incised + crush injury	1
Laceration + incised + cut throat injury	1
Total	3

Table No. 7: Type of fatal injuries

Type of fatal injuries	Total	Percentage
Contusion	21	17.06%
Stab wound	15	12.19%
Chop wound	05	4.06%
Laceration	26	21.13%
Cut throat wound	04	3.26%
Incised wound	04	3.26%
Crush injury	03	2.43%
Fractures	45	36.59%
Total	123	100%

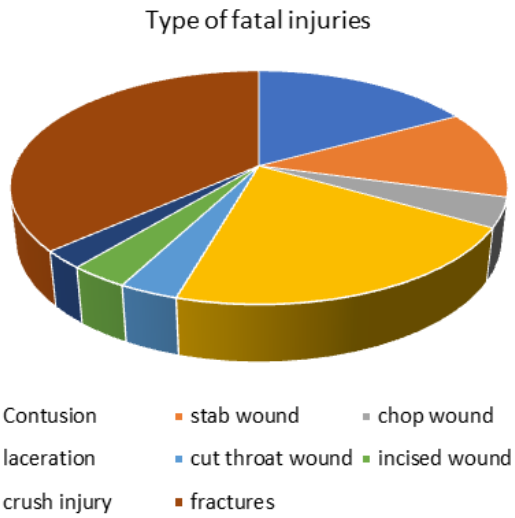


Fig No.11: Representation of types of fatal injuries.



CONTUSION concerned with PM no. 498 dated 14/08/22



LACERATION concerned with PM No.459 dated29/07/22



CUT THROAT WOUND concerned with PM No.116 dated 19/02/23



CHOP WOUND concerned with PM No.310 dated 11/05/23



CRUSH INJURY concerned with PM No.846 dated 07/12/23



STAB INJURY concerned with PM No.621 dated 10/10/22

Region affected by fatal injuries

On analysing the regions affected, (27 cases) 45% of victims have fatal injuries over their head, followed by (09 cases) 15% of victims with fatal injuries over head and chest region. The least affected were abdomen and lower limbs with one case each. Multiple areas, with contusions involving almost the entire body was observed in 07 cases (11.66%)

Table No.18: Region affected by fatal injuries

Region	No.	Percentage
Head	27	45%
Chest	07	11.67%
Abdomen	01	1.67%
Lower limb	01	1.67%
Head + Chest	09	15%
Chest + Abdomen	08	13.33%
Multiple areas (whole body)	07	11.66%
Total	60	100%

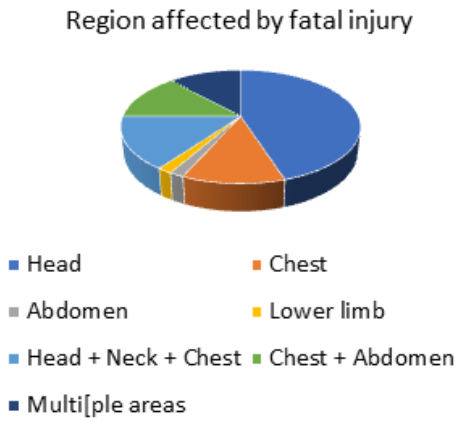


Fig No.12: Representation of region affected by fatal injuries.

Disscussion

A total of 1293 cases were autopsied during the study period of 18 months from July 2022 to December 2023, out of which, 70 (5.41%) cases were of homicidal death. Out of the 70 homicidal cases, 60 cases (4.64%) were due to mechanical injuries and 10 cases (0.77%) were excluded, as they were falling into our exclusion criteria. Similar findings were observed in study conducted by Rathod VV et al[7]where,out of total number of autopsies (3412) conducted during their study period, 179 cases (5.24%) were of death due to homicide. Also, in a study conducted by Sashikanth Z[4], out of 902medico-legal cases autopsied, 39 cases (4.3%) were reported to be alleged homicidal deaths. In the study conducted by Narayana BL et al[8], the total number of medico-legal cases autopsied was 4047, of which 163 (4.02%) cases were with history of homicide. However, in a 2 years study done by Sharp K et al[9], the total autopsies done were 2746, of which only 68 cases were alleged homicidal autopsies (2.47%). Lesser homicidal rates were also observed in study conducted by Sonawane SS et al[10] (2.11%) and Taware AA et al[11] (1.76%). In contrast to our study, higher homicidal rates of 7.84% and 10.19% were observed in studies conducted by Kumar SV et al[12] and Sangal A et al[13] respectively. This difference in homicidal rates in different regions could be attributed to diverse social interactions, economic inequality, geographical factors etc.

On analysing the fatal injuries on the victims, 30% of victims (18 cases) had more than one type of fatal injuries and 70% of victims had only one type of fatal injury, and this includes the 11 cases with surgical sutured wound (assault victims who were operated after the incident). Abrasions were not considered in our study as these are not considered fatal. Laceration was the most common individual injury observed in our study in 26 cases (21.13%), apart from fractures in 45 cases. It was followed by contusions (17.06%) and stab injuries (12.19%). The least frequent injury was crush injury (2.43 %). This is similar to the study done by Infant Raj AD et al[14], where abrasion (52.8%) was the most common injury observed, followed by fracture or dislocation in 47.2%, laceration in 44.5% and contusion in 44.5%. The least frequent injury was chop wound seen in 13.9%. In a study done by Sonawane SS et al[10], head injury (laceration and fracture) was the most common injury seen in 37.87% cases, followed by stab injury in 27.27% and pressure abrasion in 18.2% (ligature mark). However, our finding is in contrast to the study done by Buchade DD et al[15], in which abrasion was the most common injury observed (50.2%) followed by contusion (49.8%). Also, in a study done by Deepak S et al[3],27 deaths (40.29%) were observed due to fatal stab/ incised wounds. On examination of injuries suffered by victims of homicide cases, in the study conducted by Sharp K et al[9], 61.76% were abrasions and contusions. Lacerations were seen in 35.29% cases,

stab injuries in 25% and fractures in 20.58% cases. Therapeutic wounds were seen in 17.64% cases and incised wounds in 16.17% cases. Laceration being the most common injury observed corelates with the finding that blunt weapon was used in majority of the cases in our study.

The most common site of infliction of fatal injuries was over the head, in 27 cases (45%). This was followed by combined head and chest region in 09 cases (15%). Chest and abdomen together were involved in 08 cases (13.33%), whereas multiple areas involving almost the entire body were involved in 07 cases (11.66%). Only chest region was involved in 07 cases. Abdominal region and lower limb alone were involved in 01 case each. Similar finding is observed in studies conducted by Selvaraj K et al[16] where, head was the most common part of the body with injuries seen, in 37 (52.85%) cases. Also, in a study done by Verma LC et al[17], the most common site of infliction of injuries was seen over head in 17 cases (45%) followed by abdomen and chest in 6 cases (16.21%) each. In the study done by Taware AA et al[11], head, neck and face were the most commonly involved anatomical regions affecting 158(49.40%) victims, followed by limbs affecting 65(20.30%) victims. However, in contrast to our findings, in a study done by Sangal A et al[13], chest and abdomen together were the most vulnerable part injured in about half (49.33%) of the victims of homicide followed by head in 18.06%, neck in 6.63% and abdomen and chest individually in 5.28% and 3.97% respectively. Head is one of the most important and sensitive parts of the body. It is the most exposed part and hence can be easily targeted. The knowledge that the victim can be rendered helpless or may even become unconscious easily if head is targeted, may be one of the reasons why the victims are mostly attacked over the head region. Sometimes even a minor trauma, especially over the back of head, may prove fatal.

Conclusion

Out of 1293 cases autopsied during the study period, there were 70 (5.41%) cases of homicide. 60 cases, fulfilling the inclusion criteria were included in the study. Laceration was the most common individual injury observed in our study, in 26 cases (21.13%), apart from fractures in 45 cases. It was followed by contusions (17.06%) and stab injuries (12.19%). The majority of 45% of victims (27 cases) had fatal injuries on their head, followed by (09 cases) 15% of victims with fatal injuries over head and chest regions. The least affected were abdomen and lower limbs with one case each.

The number of homicidal cases has been increasing every year, not just in India but also globally. To keep the incidence of homicide under check and to make effective interventions, it is important to know the changing and varying patterns of homicides, the commonly used weapons and other demographic profile of such cases, in each region. Undoubtedly, post mortem examination has a key role to play. A meticulous examination and study of the injuries, collection of evidentiary materials will help to answer a number of questions like the manner of death, the type of likely weapon used, the identification of the assailant or the victim etc which are all pertinent in solving the crime and for the speedy delivery of the justice.

Source of funding: Nil

Conflict of interest: Nil

References

1. Slater S, Subramanyam S. An autopsy study on injuries in homicidal deaths due to weapons. Indian J Forensic Community Med 2021;8 (3):157-160.
2. Kamble NP, Parakhe SN, Swami AA, Patil VB, Deokar RB. A retrospective study of homicidal deaths autopsied at a tertiary care centre in Maharashtra. J For Med Sci Law Jan-June 2023;32(1):32-36.
3. Deepak S, Verma LC, Pramod T. A study on the pattern of injuries in homicidal deaths at MBS hospital associated with Government Medical College Kota, Rajasthan. Int J Health Res Medico Leg Prae Jan-Jun 2021;7(1):37- 41. Doi: 10.31741/ijhrmlp. v7.i1.2021.6.
4. Sashikanth Z. A Comprehensive Study on Homicidal Deaths in a Tertiary Health Care Institution in Nellore, Andhra Pradesh. Indian Journal of Forensic Medicine & Toxicology, October-December 2021,15(4); 2927-2936.
5. National crime records bureau Ministry of Home Affairs, Crime in India-2022 Statistics vol-1. (xi, 163). Available from: https://ncrb.gov.in
6. State crime records bureau Bengaluru and Police computer wing. Crime in Karnataka-2021, 18th edition. (86-88). Available from: http://karnataka.gov.in

7. Rathod VV, Choudhary UK, Ghormade PS, Keoliya AN. Study of socio-demographic profile of victims in cases of deaths due to homicide. Indian J of Forensic Community Med 2020;7(2):66–71.
8. Narayana BL, Rangaiah YKC, Khalid MA. An analytical study of homicidal deaths autopsied. J. Evolution Med. Dent. Sci. Feb 2016;5(13):540-543. DOI: 10.14260/jemds/2016/124
9. Sharp K, Devraj NA, Sonar VD. Analysis of homicidal deaths in Khandesh region of North Maharashtra. JSIMLA, September 2022;14 (2):113-117.
10. Sonawane SS, Sukhdev RB, Tyagi S, Kolle SR. Autopsy evaluation of homicidal deaths in Western Mumbai Region –2 Years Prospective study, Sch J App Med Sci, Dec 2017;5(12A):4840-4846.
11. Taware AA, Khade RV, Tatiya HS, Jadhav VT, Punpale SB. Profile of Homicidal Deaths: An Autopsy Based Study. Indian J Forensic Med and Pathol, 2018;11(3):171-178.
12. Kumar SV, Tejas J, Sivakumar SK. A cross sectional autopsy based study of homicidal deaths in Vijayapura, Karnataka. Medico-legal Update, July-September 2020; 20 (3):191-195.
13. Sangal A et al Patterns of homicidal deaths in population of western Uttar Pradesh J Indian Acad Forensic Med Jul-Sep 2019; 41(3): 191-193.
14. Infant Raj AD, Kumar SV, Venkatesha VT, Pawar GS, Maddilet B. Pattern of Injuries in Homicidal Victims in South Bangalore. J Indian Acad Forensic Med. October-Decmeber 2018;40(4):392-395.
15. Buchade DD, Bharti R, Amarnath A. Analysis of homicidal cases brought to mortuary of Lok Nayak Hospital, Delhi: A 3-Year Retrospective study. MAMC J Med Sci May-August 2019; 5(2):73-76.
16. Selvaraj K, Rajalakshmi S et al. Study of profile of homicidal deaths in South Chennai- A retrospective study. Indian Journal of Forensic Medicine & Toxicology October-December 2020, 14 (4):196-201.
17. Verma LC, Tiwari PK, Tatwal B, Joshi RB. Analysis of homicidal deaths at MBS Hospital Associated with Government Medical College Kota: An Autopsy Based Study. J For Med Sci Law 2019;28(2):19-21.
18. Kumar S et al. Cause of death profile among homicides in South India. Neuroquantology, February 2023; 21(5): 105-110.

Original Article

DOI: https://doi.org/10.37506/mpxb5p30

A Prospective Autopsy based Study on Estimation of Sex from the Sternal Parameters at Mahatma Gandhi Memorial Government Hospital, Trichy

Pary Prasath Mahendran[1], Arun Balan Mohan Kamaraj[2], Sakthivel Krishnan[3], Mithra Velusamy [4]

Assistant Professor[1], Assistant Professor[2], Assistant Professor[3], Junior Resident[4], Department of Forensic Medicine and Toxicology, Government Madurai Medical College, Madurai, Tamil Nadu.

How to cite this article: Pary Prasath Mahendran, Arun Balan Mohan Kamaraj, Sakthivel Krishnan. A Prospective Autopsy based Study on Estimation of Sex from the Sternal Parameters at Mahatma Gandhi Memorial Government Hospital, Trichy. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

In forensic medicine, anthropological investigation and the identification of skeletal remains and the method to be employed for this purpose are always important. However, the partial or total destruction of long bones reduces the possibility of successful identification. Sternum resists the effects of putrefaction and decomposition for a long period of time. The present study was conducted to analyze the correlation between the sex and various measurements of the sternum.

Aim and Objectives: To determine sex of an individual from the sternal measurements.

Materials and Methods: The data for this particular study was collected from the medicolegal autopsy cases conducted at Mahatma Gandhi Memorial Government Hospital, Trichy. 150 intact sternums belonging to both the sexes aged more than1 year and less than 40 years was taken as the study material.

Result: It was established that a subject may be male if the following conditions are present- The sternum's body is longer than 9.3 cms or more, Manubrium length is larger than 4.65 cms or more, the sternal index is 48.9 or less and the overall sternum is longer than 14.25cms or more. If the following conditions are present, a subject may be female - The sternum's body is lesser than 9.3cms, Manubrium length is lesser than 4.6 cms, the sternal index is 49 and more and the overall sternum is lesser than 14.25cms.

Conclusion: In our study, the length of body of sternum can be taken as the most reliable sternal parameter for determining the sex followed by the total sternal length. All the sternal parameters except the sternal index were on the higher limits for males.

Keywords: Sternum; sternal parameters; sex.

Introduction

Identification is the determination of the individuality of a person, whether living or dead[1]. It is one of the most important duties of the medico legal experts to assist the investigating agency. The medico legal expert's service in the field of identification is sought during mass disasters,

Corresponding Author: Pary Prasath, Assistant Professor Department of Forensic Medicine and Toxicology, Government Madurai Medical College, Madurai, Tamil Nadu.

E-mail: doctorpary2@gmail.com

Submission date: Feb 21, 2025 **Acceptance date:** March 28, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

advanced decomposition and extremely mutilated bodies, skeletal and fragmentary remains and much more. Apart from legal reasons, the identification is also important for civil purposes like dispute of inheritance, marital reasons, disputed sex etc., and for humanitarian reasons like identification of the deceased. Forensic Anthropology gained importance in recent days due to the fact that experts often have to rely on the bones in their work. Sex, race, age and stature is considered as the "big four" parameters in forensic identification. Other criteria for establishing the identity of an individual include moles, scars, color of an individual, tattoo marks, finger prints and DNA profiles[1]. Many experts consider racial features in identification of an individual to be an outdated concept. For personal identification, determining sex is an important criterion. This task is easier if primary and secondary sexual characteristics of the individual are intact. However, in cases of concealed sex, intersex conditions or when only skeletal remains are available, a vast knowledge and careful scientific approach are required to ascertain the sex of the individual. The sternum is a superficial bone that can be easily procured without disturbing the routine autopsy procedures and remains intact even in the advanced decomposition. Considering these factors, the present study is an earnest effort to establish the sex of an individual through measurements of sternal parameters.

Research Gap:

1. **Limited Use of Sternal Measurements in Sex Determination** – While many studies have focused on pelvis and skull morphology for sex determination, research on the use of sternal parameters remains relatively limited.
2. **Variability in Population Data** – Existing studies on sternal measurements are often based on specific populations, and their applicability to diverse ethnic groups remains unclear.
3. **Lack of Standardized Methodology** – Different studies use varying measurement techniques and statistical analyses, leading to inconsistencies in results.

Need for the Study:

1. **Sternum and reliable parameters** – The sternum remain intact even in advanced decomposition and can be accessed without disrupting routine autopsy procedures, making it a reliable structure for sex determination when other skeletal elements are missing.
2. **Contribution to Population-Specific Data** – This study will help establish baseline sternal measurements for sex determination in a specific population, aiding forensic experts in more accurate identifications.

Aim and Objectives:

- To determine sex of an individual from the sternal measurements.

Materials and Methods

The present study was carried out in the Department of forensic medicine and toxicology, K.A.P.Vishwanatham Government Medical College and Mahatma Gandhi memorial government hospital, Trichy from November 2021 to April 2022.The study sample consisted of 150 deceased individuals who were subjected to medico-legal autopsy at the mortuary wing attached to Mahatma Gandhi memorial Government Hospital, Trichy.

To determine sex, the following osteometric parameters were used in the analysis:

1. Total sternum length (TL)
2. The length of the sternum's body (BL)
3. Manubrium length (ML)
4. Sternal index (SI):

(Length of manubrium/Length of body of the sternum) ×100

A vernier caliper was used to measure the osteometric parameters.

Limitations of the Study:

We cannot perform this study, if there is any,

1. Injury to the sternum.
2. Deformities of chest wall - both congenital and acquired.

PHOTOGRAPHS



Fig 1: PROCEDURE OF REMOVAL OF STERNUM



Fig 2: MEASURING THE LENGTH OF MANUBRIUM STERNI BY DIGITAL VERNIER CALIPER

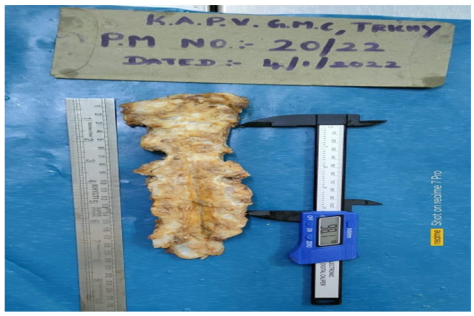


Fig 3: MEASURING THE LENGTH OF BODY OF THE STERNUM

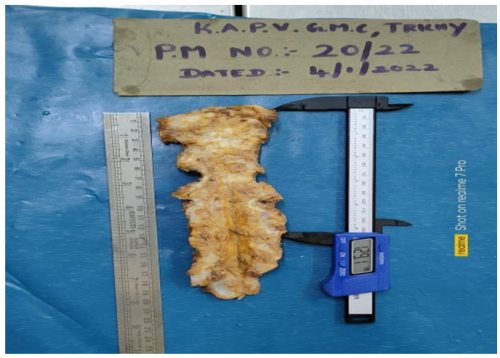


Fig 4: MEASURING THE TOTAL STERNAL LENGTH

FINDINGS:

DISTRIBUTION OF THE PARTICIPANTS:

- 22.7% participants were in the age group 21 to 25 years followed by 20% in the age group 36 to 40 years.
- 72% participants were males and 28% were females.

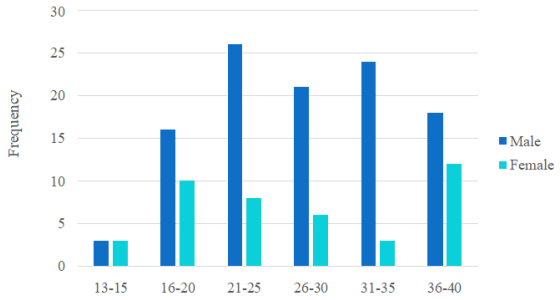


Fig 5: Bar chart showing distribution of participants.

DISTRIBUTION ACCORDING TO LENGTH OF MANUBRIUM:

46% participants were having manubrium length of 5.1 to 6 cms and 26.7% were having length of 4.1 to 5 cms.

Table 1: Distribution according to length of manubrium.

Variables		Frequency (n=150)	Percentage (%)
Length of manubrium (in cms)	2.9-4	28	18.7
	4.1-5	40	26.7
	5.1-6	69	46
	>6	13	8.7

DISTRIBUTION ACCORDING TO LENGTH OF BODY OF STERNUM:

46% participants were having length of body of sternum of 11 to 13 cms followed by 30% with length of 9 to 10.9 cms.

Table 2: Distribution according to length of body of sternum.

Variables		Frequency (n=150)	Percentage (%)
Length of body of sternum (cms)	<7	12	8
	7-8.9	24	16
	9-10.9	45	30
	11-13	69	46

DISTRIBUTION ACCORDING TO TOTAL STERNAL LENGTH:

56% were having sternal length of 14.1 to 18 cms followed by 24.7% with sternal length of 10.1 to 14 cms.

Table 3: Distribution according to total sternal length.

Variables		Frequency (n=150)	Percentage (%)
Total sternal length (in cms)	≤ 10	7	4.7
	10.1-14	37	24.7
	14.1-18	84	56
	18.1-20	22	14.7

DISTRIBUTION ACCORDING TO STERNAL INDEX:

40% were having sternal index of 45.1 to 48 followed by 31.3% with sternal index 48.1 to 51.

Table 4: Distribution according to sternal index.

Variables		Frequency (n=150)	Percentage (%)
Sternal index	42-45	14	9.3
	45.1-48	60	40
	48.1-51	47	31.3
	51.1-55	29	19.3

COMPARISON OF MEAN LENGTH OF MANUBRIUM BETWEEN MALE AND FEMALE:

The mean length of manubrium among the males was 5.31 ± 0.54 cms and that of females was 3.96 ± 0.52 cms. The mean length of manubrium was more among males than females with P value of less than 0.05.

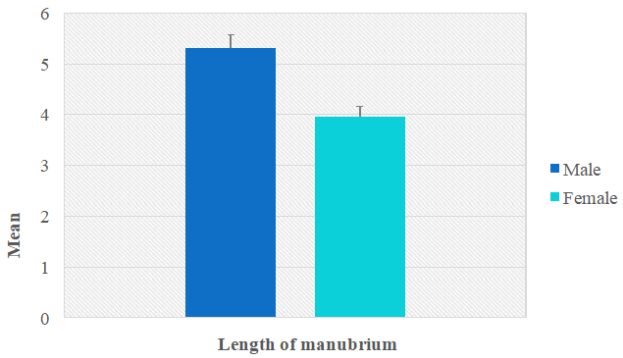


Fig 6: Bar chart showing comparison of mean length of manubrium between male and female.

COMPARISON OF MEAN LENGTH OF BODY OF STERNUM BETWEEN MALE AND FEMALE:

The mean length of body of sternum among the males was 11.28 ± 1.02 cms and that of females was 7.67 ± 1.11 cms. The mean length of body of sternum was more among males than females with P value of less than 0.05.

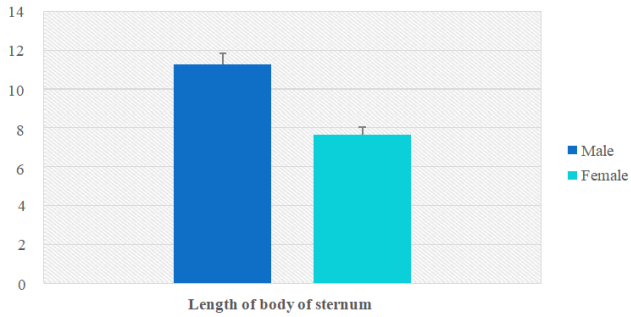


Fig 7: Bar chart showing comparison of mean length of body of sternum between male and female.

COMPARISON OF MEAN TOTAL STERNAL LENGTH BETWEEN MALE AND FEMALE:

The mean total sternal length among the males was 16.60 ± 1.54 cms and that of females was 11.64 ± 1.63 cms. The mean total sternal length was more among males than females with P value of less than 0.05.

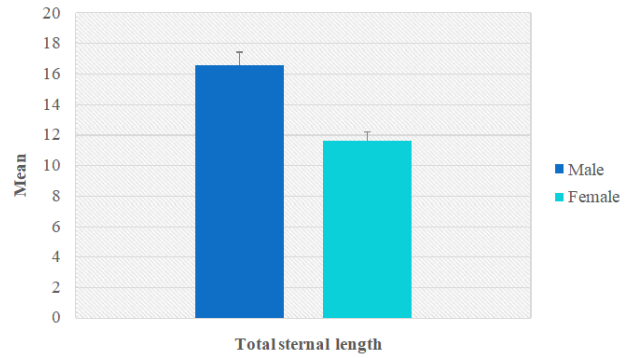


Fig 8: Bar chart showing comparison of mean total sternal length between male and female.

COMPARISON OF MEAN STERNAL INDEX BETWEEN MALE AND FEMALE:

The mean sternal index among the males was 47.04 ± 1.77 cms and that of females was 51.76 ± 1.67 cms. The mean sternal index was more among females than males with P value of less than 0.05.

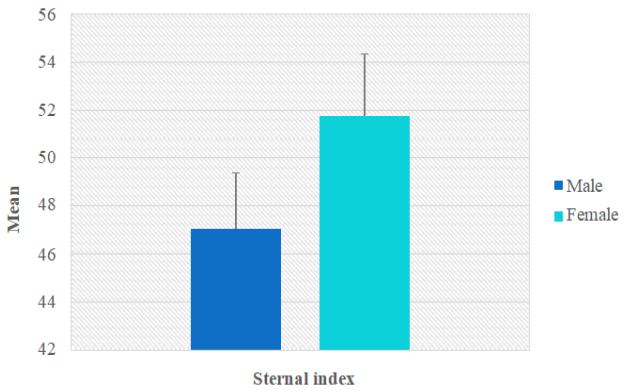


Fig 9: Bar chart showing comparison of mean sternal index between male and female.

ROC CURVE OF LENGTH OF MANUBRIUM FOR DETERMINING THE ACTUAL SEX:

- The area under the curve was 0.962 (95% CI 0.936 – 0.988).
- Length of manubrium could be efficient tool for determining male sex.
- Based on the co-ordinates the cut off determined was 4.65.
- If the length of the manubrium was more than or equal to 4.65cms, then it could be males and less than that of 4.65cms could be females.

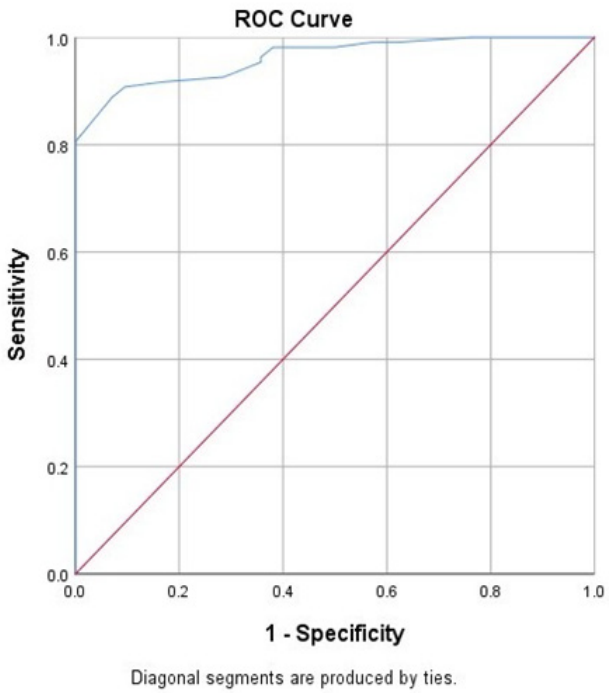


Fig 10: ROC curve of length of manubrium for determining the actual sex.

ROC CURVE OF LENGTH OF BODY OF STERNUM FOR DETERMINING THE ACTUAL SEX:

- The area under the curve was 0.989 (95% CI 0.974 – 1.00).
- Length of body of sternum could be efficient tool for determining male sex.
- Based on the co-ordinates the cut off determined was 9.3.
- If the length of body of sternum was more than or equal to 9.3cms, then it could be males and less than that of 9.3cms could be females.

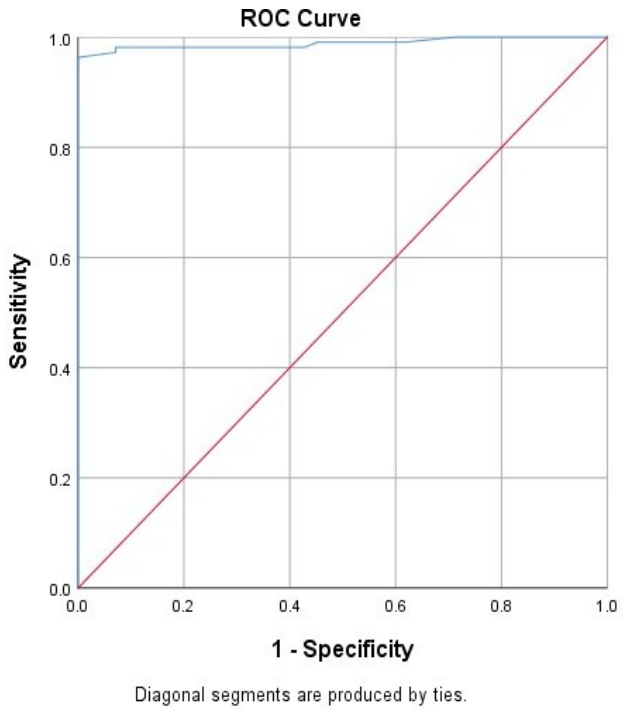


Fig 11: ROC curve of length of body of sternum for determining the actual sex.

ROC OF TOTAL STERNAL LENGTH FOR DETERMINING THE ACTUAL SEX:

- The area under the curve was 0.985 (95% CI 0.970 – 1.00).
- Total sternal length could be efficient tool for determining male sex.
- Based on the co-ordinates the cut off determined was 14.25.
- If the total sternal length was more than or equal to 14.25 cms, then it could be males and less than that of 14.25 cms could be females.

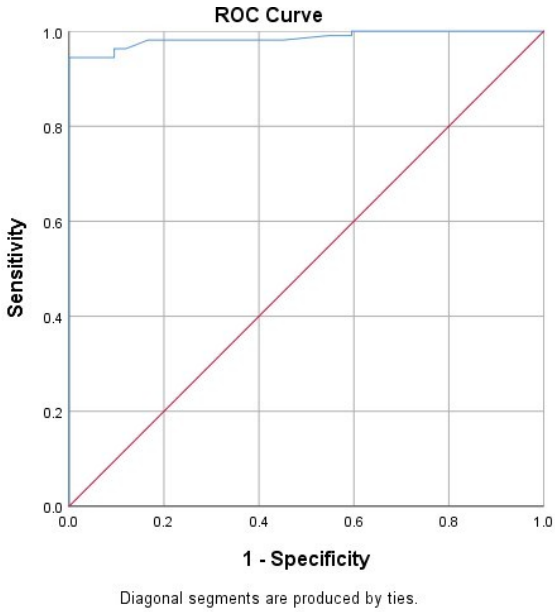


Fig 12: ROC of total sternal length for determining the actual sex.

ROC OF STERNAL INDEX FOR DETERMINING THE ACTUAL SEX:

- The area under the curve was 0.978 (95% CI 0.956 – 1.00).
- Sternal index could be efficient tool for determining male sex.
- Based on the co-ordinates the cut off determined was 48.9.
- The Sternal index with the score of less than or equal to 48.9 could be males and more than the cut off value could be females.

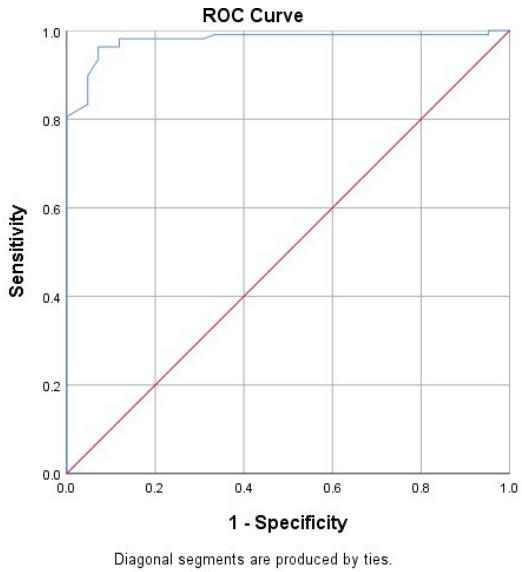


Fig 13: ROC of sternal index for determining the actual sex.

Discussion

The observations presented highlight the consistent trend that most skeletal metrics, with the exception of sternal index, show larger values in males. In all the earlier researches, the sternal index was consistently found to be high in females. The results obtained from this study are in accordance with the above statement [4,6,7,8,9].

Males were found to have a substantially longer mean sternum length (11.2 cms) than females (7.67cms). Males have a substantially longer mean total sternum length (16.6cms) than females do (11.6cms). In females, the manubrium is longer than the body of the sternum by more than half, but in males, the body of the sternum is at least twice as long as the manubrium [1,2,3].

All previous studies, i.e., a value above which the sternum could be sexed as male and a value below which it could be sexed as female, provide two cut off values for sex determination. No sex-related opinion can be drawn if the value found for a specific sternum falls between these cutoff ranges. It appears clear that it is impossible to determine the sex for those sterna with measurements within these limitations.

Only a clear cutoff value over or below which the sternum can truly be sexed is mentioned in the current study. In order to help with sex identification, this study also offers the mean value for every sternal parameter (sex wise).

Thus, it can be established that a subject may be **male** if the following conditions are present:

1. The sternum's body is longer than 9.3 cms or more.
2. Manubrium length is larger than 4.65 cms or more.
3. The sternal index is 48.9 or less.
4. The overall sternum is longer than 14.25cms or more.

If the following conditions are true, a subject may be **female**:

1. The sternum's body is lesser than 9.3cms.
2. Manubrium length is lesser than 4.6cms.
3. The sternal index is 49 and more.
4. The overall sternum is lesser than 14.25cms.

Length of body of sternum can be taken as the most reliable sternal parameter for determining the sex followed by the total sternal length.

KNOWN LEARNINGS:

1. **Sexual Dimorphism in Sternal Measurements**
    - Males generally have larger skeletal metrics than females, except for the sternal index, which is higher in females.
    - The sternum's body is significantly longer in males, while in females, the manubrium is relatively longer than the sternum's body.
2. **Limitations in Sex Classification**
    - If sternal measurements fall within certain intermediate ranges, accurate sex classification remains uncertain.

UNKNOWN LEARNINGS:

1. **Confirmation of Sternal Trends in Sexual Dimorphism**
    - The study reinforces that males have a significantly longer total sternum and sternum body length, while females have a higher sternal index.
    - It confirms that in females, the manubrium is proportionally longer compared to the body of the sternum, whereas in males, the sternum's body is at least twice as long as the manubrium.
2. **Reliability of Sternal Parameters for Sex Determination**
    - The length of the sternum's body is identified as the most reliable metric for sex determination, followed by the total sternal length.
    - The study provides mean values for each sternal parameter based on sex, improving the precision of identification.
3. **Defined Cutoff Values for Sex Determination**
    - Unlike previous studies that acknowledged difficulty in classifying sterna with intermediate measurements, this study establishes clear cutoff values for sex determination based on sternal parameters.

CONCLUSION

To ascertain a person's sex, the Sterna obtained from 150 documented cases of medicolegal autopsy performed between November 2021 and April 2022 were examined.

The given criteria provide a method for determining the probable biological sex of a subject based on sternal measurements.

Males tend to have a longer sternum body, a longer manubrium, a lower sternal index and an overall greater sternum length. In contrast, females generally have a shorter sternum body, a shorter manubrium, a higher sternal index and a shorter overall sternum length.

Length of body of sternum can be taken as the most reliable sternal parameter for determining the sex followed by the total sternal length.

These measurements can be useful in forensic anthropology and osteological studies for sex determination.

CONFLICT OF INTEREST: NONE DECLARED.

SOURCE OF FUNDING: SELF.

ETHICAL CLEARANCE: ETHICAL COMMITTEE APPROVAL OBTAINED FROM INSTITUTIONAL ETHICAL COMMITTEE, KAPV MEDICAL COLLEGE, TRICHY. Ref no: KAPV/ IEC/ 2021/ 022 dated 24.10.2021.

Reference

1. Aggrawal A. Textbook of Forensic Medicine and Toxicology. 1st ed. New Delhi: Avichal Publishing Company; p. 59-60.
2. Stewart TD. Essentials of Forensic Anthropology. Springfield: Charles C. Thomas; p. 95.
3. Reddy KSN. The Essentials of Forensic Medicine & Toxicology. 35th ed. 2022. p. 46.
4. Gautham RS, Shah. The Human Sternum as an Index of Age & Sex. J Anat Soc India. 2003;52(1):20-23.
5. Singh M, Siddamsetty AK, Sreenivas M, Naagar S. Sex determination from morphometry of sternal end of 4th rib at autopsy. J Indian Acad Forensic Med. 2022;44(2):62-6.

6. Atal DK, Tyagi A. Morphometrical analysis of sternum bone for sexual dimorphism estimation– An autopsy based study. J Forensic Med Toxicol. 2020;37(1):38-45.
7. Kumar A, Tyagi AK, Sreenivas M. Anthropometry of the sternum: An autopsy-based study for sex determination. J Forensic Leg Med. 2022;88:102336.
8. Al-Shamout R, Al-Khateeb M. Estimation of sex based on metrics of the sternum in a contemporary Jordanian population: A computed tomographic study. Forensic Imaging. 2022;29:200452.
9. Babu S, Palimar V, Rao AS, Gupta C, Nayak VC, Kumar A, et al. Determination of sex from human adult sternum. J Punjab Acad Forensic Med Toxicol. 2019;19(2):130-3.
10. Singh J, Pathak RK. Sex determination from sternum by discriminant function analysis in a North Indian population. J Forensic Leg Med. 2013;20(5):402-8.
11. Kanchan T, Krishan K, Sharma A. Sex determination from sternum: A forensic perspective. J Forensic Leg Med. 2010;17(4):187-9.
12. Açikgöz A, Yavuz MF. Sex estimation from sternal measurements in a contemporary Turkish population. Int J Leg Med. 2021;135(1):283-9.
13. Gandhi N, Kanchan T. Anthropometry of the sternum: An autopsy-based study for sex determination in a Central Indian population. J Forensic Leg Med. 2022;91:102403.
14. Saini V, Srivastava R, Rai RK, Shamal SN, Singh TB. Estimation of sex based on sternal measurements in an Indian population. J Forensic Sci. 2012;57(2):310-5.
15. Abdi M, Saba H. Sex estimation from sternal dimensions: A discriminant function analysis in Iranian population. J Forensic Leg Med. 2014;27:41-4.

Original Article

DOI: https://doi.org/10.37506/prx8rh41

Poisoning deaths at a Medical college in Rural Area of Northern India: A Five-year Retrospective Autopsy-based Study

Vipan Bhandari[1], Nitin Malik[2], Kanika Kohli[3], K.K Aggarwal[4]

[1]ASMO Civil Hospital Ambala Cantt., Haryana, India, [2]Junior Resident, [3]Professor, [4]Professor & Head, Department of Forensic Medicine and Toxicology, Maharishi Markandeshwar Institute of Medical Sciences And Research, Mullana (Ambala), Haryana, India.

How to cite this article: Vipan Bhandari, Nitin Malik, Kanika Kohli et. al. Poisoning deaths at a Medical college in Rural Area of Northern India: A Five-year Retrospective Autopsy-based Study. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 4, October-December 2025.

Abstract

One of the most important issues facing public health is mortality after acute poisoning. The current study intends to evaluate the trends in poisoning-related deaths in a tertiary care facility and investigate the results of autopsies on these deaths. This retrospective study, which is based on autopsies, was carried out with institutional ethical committee approval. Version 20 of the SPSS software was used to evaluate and analyze descriptive data in order to investigate the distribution of cases among various age groups, genders, and toxic chemical kinds. A total of 94 cases were recorded. The majority were young adults of 21-30 years (36.2%). Males were predominantly involved (58.5%). A majority (91.5%) were living in the rural areas. Most of the patients were hospitalized (72.3%). 98.9% of the dead bodies showed no sign of decomposition but showed signs of cyanosis. Congested gastric mucosa was seen in 37.2% of the cases. Also, 37.2% of the cases showed congested gastric mucosa with a garlicky smell. In most cases, the poisonous compound was aluminum phosphide (70.2%). Suicidal deaths contributed to the higher frequency of the cases (91.5%). The findings imply that recommendations for the proper handling, storage, transportation, and selling of poisonous compounds should be defined while taking into account the groups of young teenagers without considering their sexual orientation.

Keywords: Acute poisoning, organophosphates, Aluminium Phosphide, Autopsy.

Introduction

Worldwide, poisoning, whether deliberate or unintentional, increases mortality and morbidity. Within a certain area, depending on several factors like the population's socioeconomic status, the availability of various poisons, and cultural and religious influences. One of the top three causes of mortality worldwide is suicide. Intentionally taking poisons or overdosing on drugs, often impulsively due to psychological distribution or some disputes, is termed deliberate poisoning. Suicide utilizing poisoning is less prevalent in developed countries than in developing countries.[1]

"A poison is a substance that can cause harm or

Corresponding Author: Nitin Malik, Junior Resident Department of Forensic Medicine and Toxicology, Maharishi Markandeshwar Institute of Medical Sciences And Research, Mullana (Ambala), Haryana, India.

E-mail: nitinmalik4358@gmail.com

Submission date: May 6, 2025 **Acceptance date:** July 5, 2025 **Published date:** October 13, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

death when ingested, inhaled, absorbed, or injected into a living organism." It can act locally, systemically, or both. However, this definition of poison is not satisfactory, as the same substance that causes toxic effects can also be beneficial in particular doses, as in the case of many drugs used for treatment, it can cause toxicity in higher doses. The founder of contemporary toxicology, Paracelsus, has stated, "All things are poison, and nothing is without poison. It is the dose that determines them as poison."[2]

The type of poisoning differs by country and even within similar locations such as states and districts.[3] Pesticides are the most common cause of poisoning in developing countries, including India. It is known to be because of the agriculture-based economy since 1985. In India, aluminum phosphide is the most common substance causing poisoning, which was barbiturates and copper sulfate in the seventies and organophosphorous compounds (OPCs) in the eighties.[4]Different parts of the nation have different poisoning patterns.

In rural India poisoning deaths are a significant public health problem, but most researches tends to be conducted in urban populations. There is a paucity of data on rural Northern India patterns, causes, and outcomes. This study was conducted in order to gain further understanding of the widespread health and social issue of poisoning deaths. The actual situation of self-poisoning in the area would be illustrated by the present trends of poisoning deaths in the rural districts of this region, This study aims to fill the research gap in this region of India to provide an improved understanding of local trends and to inform successful prevention, treatment, and policy initiatives. The current study sought to evaluate the trends in poisoning-related mortality at a tertiary care facility and examine the results of autopsies on poisoning deaths.

Material and Methods

It is an autopsy-based retrospective study.The data was collected from the reports of the autopsies conducted on the dead bodies of deaths due to poisoning from the postmortem record maintained in the Department of our institution, during 5 years from 01 January 2016 to 31 December 2020. Using a variety of statistical methods, a thorough statistical analysis of the sociodemographic factors was conducted. Descriptive statistical methods were used to analyse various epidemiological and demographic parameters. Before using the available data, ethical approval was acquired from MMIMSR's Institutional Ethics Committee in Mullana, Ambala, Haryana, under project number IEC 19P dated 19/01/22.

Results

According to Age

The study comprised 94 deaths due to poisoning out of which one (1.1%) was in the age group <10 years; 12 (12.8%) in 11-20 years; 34 (36.2%) in 21-30 years; 21 (22.3%) in 31-40 years; 15 (16%) in 41-50 years; 8 (8.5%) in 51-60 years; and 3 (3.2%) in > 60 years. Most of the deceased were in the age range of 21-30 years, followed by 31-40 years (Table 1)

Table 1: Shows the distribution of poisoning deaths by age.

Age	n (%)
0-10 years	1 (1.1%)
11-20 years	12 (12.8 %)
21-30 years	34 (36.2 %)
31-40 years	21 (22.3 %)
41-50 years	15 (16.0 %)
51-60 years	8 (8.5 %)
>60 years	3 (3.2 %)
Total	94 (100.0 %)

According to Gender

The gender distribution of enrolled patients comprised 39 (41.5 %) females and 55 (58.5 %) males.

According to Residence

The data showed that out of 94, 86 (91.5%) lived in rural areas, and 8 (8.5%) were domiciled in urban areas.

According to Hospitalization

The data showed that out of 94 cases, 68 (72.3%) were hospitalized and 26 (27.7%) were brought dead to the hospital.

Distribution according to Internal findings

Congested gastric mucosa was seen in 35 (37.2%), congested gastric mucosa with the smell of garlic was

seen in 35 (37.2%), congested gastric mucosa with the smell of kerosene was seen in 10 (10.6%), congested gastric mucosa with smell of alcohol was seen in 4 (4.3%), congested gastric mucosa with blackish fluid was seen in 4 (4.3%), congested gastric mucosa with other findings was seen in 3 (3.2%), congested gastric mucosa with greenish fluid was seen in 2 (2.1%), and congested gastric mucosa, with smell of garlic and presence of blackish fluid was seen in 1 (1.1%) patient **(Table 2).**

Table 2: The table shows allocation according to internal findings of the stomach.

Internal findings of Stomach	Number (Percentage %)
Gastric mucosa congested	35 (37.2%)
Gastric mucosa congested, garlic smell present	35 (37.2 %)
Gastric mucosa congested, kerosene smell present	10 (10.6 %)
Gastric mucosa congested, alcohol smell present	4 (4.3 %)
Gastric mucosa congested, blackish fluid present	4 (4.3 %)
Gastric mucosa congested, others	3 (3.2 %)
Gastric mucosa congested, greenish fluid present	2 (2.1 %)
Gastric mucosa congested, garlic smell present, blackish fluid present	1 (1.1 %)
Total	94 (100.0 %)

According to cause of death/type of poison

The cause of death in 66 (70.2%) patients was aluminum phosphide. In 22 (23.4%), it was OPC poisoning. In 4 (4.3%), it was alcohol intoxication. In 1 (1.1%), it was naphthalene poisoning, and in 1 (1.1%) it was kerosene poisoning.

Distribution according to manner of death

Accidental death was seen in 8 (8.5%) patients, and suicidal death in 86 (91.5%) patients. No homicidal poisoning cases were reported in the present study (Table 3).

Table 3: The table displays the allocation of cases based on the type and manner of fatal poisoning.

Type of Fatal Poison	Manner of Poisoning	
	Suicidal (N=86)	Accidental (N=8)
Aluminum phosphide (N=66)	65	1
Organophosphate poisoning (N=22)	20	2
Alcohol intoxication (N=4)	0	4
Naphthalene poisoning (N=1)	0	1
Kerosene poisoning (N=1)	1	0

Discussion

During these five years, 793 autopsies were done, from which 94 cases (11.8%) were of deaths due to poisoning taken in this study. Most cases were in the age group of 21-30 years, accounting for 36.2%. Similar age-group were reported by other studies involving fatal poisoning.[5-7] Whereas, a study by Pan et al. on poisoning deaths found maximum fatalities in the age group of 31-40 years.[8] The higher prevalence of poisoning among young adults is indicative of their susceptibility to stress, which may be brought on by relationship or exam failure or dissatisfaction, maladjustment, or an inability to handle their parent's high expectations. Overall, young adults are emotionally unstable and immature enough to tolerate extreme mental or physical trauma. Males were predominant in our study. Similar findings were noted in most of the studies on fatal poisoning.[8-10] The males are considered breadwinners in the families and rural areas, whereas culturally, females are considered to take care of the household. Males get overburdened and stressed, accounting for the majority of the cases.

We encountered the majority of the cases from rural areas, accounting for 91.5% of the cases. Similarly, Pan et al. and Mehrpour et al. showed a higher frequency of poisoning cases in rural areas. On examination in our study, the condition of the body was found to be cyanosed in 98.9% of the cases. From our extensive research, we could not find

studies with similar findings. Chavan et al. noticed cyanosis in 30% of the deaths.[12] In the present study, the most common internal autopsy finding was only gastric mucosal congestion and gastric mucosal congestion with garlic smell present accounting for 37.2% of the cases each. Similarly, Chavan et al. and Job et al. observed gastric mucosal congestion in most cases.[12,13]

Aluminium phosphide constituted 70.2% of the fatal poisoning in the present study. Similarly, Parel et al., Singh et al., and Garg et al. also majorly observed aluminium phosphide poisoning.[14-16] However, OPCs were the major culprit in several studies.[17-24] These variations in frequency could result from variations in the availability of the toxic drugs and their patterns of usage.

The majority of cases were due to deliberate consumption of poison. Similar findings were noticed in the majority of the studies.[8,14,19-23,25,26] The majority of the cases were hospitalized before death. Similarly, Pan et al. observed most of the poisonings underwent treatment before death.

Conclusion

The study highlights that poisoning remains a significant cause of unnatural death, particularly among young adults aged 21–30 years, with males from rural backgrounds being the most affected. The high incidence among young individuals suggests underlying psychosocial stressors and emotional vulnerability. Aluminium phosphide emerged as the most common toxic agent, reflecting its accessibility in rural settings. Most poisonings were deliberate in nature, and the majority of victims received medical attention before death. In our study we observed the findings of cyanosis in most of the cases of fatal poisoning. All the cases had gastric mucosal congestion and more than half of the cases had peculiar smell on opening the stomach. These findings underline the urgent need for mental health support, stricter regulation of toxic substances, and improved healthcare access in rural regions to mitigate fatal poisoning incidents. Every tertiary care facility should be required to have a poison detection center with all the latest equipment and skilled personnel for prompt and improved handling of acute poisoning situations. Government agencies should create awareness about various substances that can cause fatal poisoning. Precautions related to handling, transportation, and storage of toxic materials should be taken.

Limitations: In our available records data, regarding how the deceased accessed the poison was not available uniformly.

Funding: This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest: The authors have no conflict of interest to declare.

Ethical Approval: The ethical approval for the study was obtained from the Institutional Ethics Committee, Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, Haryana, India (IEC-19 P/MMIMSR).

Authors Contributions: All authors have contributed equally to the study and approved the final draft of the manuscript.

Acknowledgment: The authors would like to thank the office staff and mortuary assistants of the Department of Forensic Medicine and Toxicology, Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, Haryana, India, for their help in accessing the medicolegal autopsy records.

References

1. Kannan K. Toxicology. In: Modi A Textbook of Medical Jurisprudence and Toxicology. 26th ed, Gurgaon, India, 2012, Lexis Nexis (A Division of RELX India Pvt Ltd); 2019: 13.
2. Dikshit PC. General Toxicology. In: Textbook Of Forensic Medicine And Toxicology Principles And Practice. 2nd ed, New Delhi, India: Peepee Publishers And Distributors (P) Ltd; 2013: 438-9.
3. Bhowmick K, Ghosh B, Pain S.A Study on Deliberately Self-Poisoned In-Hospital Patients in a Tertiary Health Care Center in Northeast India: A Cross-Sectional Review. J Emerg Med. 2019;56(5):512-18.
4. Prajapati T, Prajapati K, Tandon NR, Merchant S. A study of acute poisoning cases excluding animal bites at Civil Hospital, Ahmedabad. J Indian Acad Forensic Med. 2013;35(2):120-2

5. Curran WJ. The Medico-legal autopsy and Medicolegal investigation. Bull N Y Acad Med. 1971;47(7):766–75.
6. ME Bansude, Kachare RV, Dode CR. Trends of unnatural deaths in latur district of Maharashtra. Journal Forensic Med. 2012;21(2):7–9.
7. Zhao CJ, Dang XB, Su XL, Bai J, Ma LY. Epidemiology of Suicide and Associated Socio-Demographic Factors in Emergency Department Patients in 7 General Hospitals in Northwestern China. Med Sci Monit. 2015;21:2743-9.
8. Pan AK, Malle AK, Hamza NC, Das A. Profile Of Fatal Poisoning In Autopsy Cases At A Tertiary Care Hospital In Port Blair (Andaman And Nicobar Islands): A Seven-Year Retrospective Study. J Forensic Med Toxicol. 2024;41(2):172-8.
9. Dash SK, Aluri SR, Mohanty MK, Patnaik KK, Mohanty S. Sociodemographic profile of poisoning cases. J Indian Acad Forensic Med. 2005;27:133–8.
10. Chatterjee S, Verma VK, Hazra A, Pal J. An observational study on acute poisoning in a tertiary care hospital in West Bengal, India. Perspect Clin Res. 2020;11(2):75-80.
11. Mehrpour O, Akbari A, Jahani F, Amirabadizadeh A, Allahyari E, Mansouri B, Ng PC. Epidemiological and clinical profiles of acute poisoning in patients admitted to the intensive care unit in eastern Iran (2010 to 2017). BMC Emerg Med. 2018 19;18(1):30.
12. Datir SB, Petkar M, Farooqui JM, Makhani CS, Hussaini SN, Chavan KD, Bangal RS, Datir S, Center P, Farooqui J, Hussaini SN. Study of outcome in acute poisoning cases in rural region of Western Maharashtra. J Forensic Leg Med Title. 2015;24:1-7.
13. Job C: A retrospective study of poisoning cases in Thrissur district of Kerala for the year 1995. Journal of Indian Society of Toxicology. 2009;5(1):23-27
14. Parekh U, Gupta S. Epidemio-toxicological profile of poisoning cases-A five years retrospective study. J Forensic Leg Med. 2019 1;65:124-32.
15. Singh SP, Aggarwal AD, Oberoi SS, Aggarwal KK, Thind AS, Bhullar DS, Walia DS, Chahal PS. Study of poisoning trends in north India–a perspective in relation to world statistics. Forensic Leg Med. 2013 1;20(1):14-8.
16. Garg V, Verma SK. Trends of poisoning in rural area of South-West, Punjab. Journal of Indian Academy of Forensic Medicine. 2010;32(3):189-93.
17. Singh DP, Aacharya RP. Pattern of Poisoning Cases in Bir Hospital. J Inst Med. 2007;28(1):3–6.
18. Kanchan T, Menezes RG. Suicidal poisoning in Southern India: gender differences. J Forensic Leg Med. 2008;15(1):7–14.
19. Maharani B, Vijayakumari N. Profile of poisoning cases in a tertiary care hospital, Tamil Nadu, India. J Appl Pharm Sci. 2013;3(1):91–4.
20. Bhagora RV, Parmar DJ, Desani CA, Doctor R. Fatal Poisoning Cases Brought for Postmortem Examination at Mortuary Profile Study of Fatal Poisoning Cases Brought for Postmortem Examination at Mortuary of Sir Takhtsinhji General Hospital, Bhavnagar (Gujarat). Int J Res Med. 2015;4(3):59–63.
21. Pipaliya KN, Aghera VJ, Patel MN, Vaghela RD, Masharu RK. Profile of Fatal Poisoning Cases in and Around Rajkot Region: A 3 Years Retrospective Study. Indian Journal of Forensic Medicine and Pathology. 2016;9(3):101-4.
22. Gouda S, Rao MS. Profile of Poisoning Cases in a Tertiary Care Hospital. Medicolegal Update. 2017;17(1):234–7.
23. Poluru VV, Mamatha K. A Study of Common Type of Poisoning in the Cases Referred for Medicolegal Autopsy at Sri Venkateswara Medical College, Tirupati. Medico-Legal Update. 2017;17(1):151-6.
24. Mugadlimath A, Kadagoudar S, Sheelvant S, Bambeshwar K. Profile of Medicolegal Autopsy Cases at Tertiary Care Centre in Bagalkot, Karnataka. Indian Journal of Forensic Medicine and Pathology. 2017;10(2):63-6.
25. Goswami O, Mahanta P, Kalita D, Konwar R, Yadav DS. A Three-Year Study on Acute Poisoning Cases Brought for Medico-Legal Autopsy in a North-Eastern City of India. Open Access Emerg Med. 2021 12;13:45-50.
26. Patel DJ, Tekade PR. Profile of organophosphorus poisoning at maharani hospital, Jagdalpur, Chhattisgarh: a three years study. J Indian Acad Forensic Med. 2011;33:102-105.

DOI: https://doi.org/10.37506/w076hy84

Erratum to: Applications of Reverse Panoramic Radiography for Age and Gender Determination – A Radiographic Study, Indian Journal of Forensic Medicine & Toxicology, Vol. 15, No. 3, July–September 2021.

https://medicopublication.com/index.php/ijfmt/article/view/15315

In the above-mentioned article, Figure 1 (Anatomic parts of the lambdoid suture) was adapted from the following source:

Sunira Chandra, Shweta Dwivedy, Kunal Sah, Shruti Sinha. Application of modified reverse panoramic radiograph on lambdoid suture for age estimation. Quant Imaging Med Surg. 2015;5(4):519–523.

doi:10.3978/j.issn.2223-4292.2015.04.02

The figure credit was inadvertently omitted in the original publication. The authors regret this oversight and wish to give due acknowledgment to the original authors.

The image in question should be correctly attributed to Dr. Shweta Dwivedy et al., as cited above. We request that readers be informed accordingly. The correct citation is mentioned below

Chandra S, Dwivedy S, Sah K, Sinha S. Application of modified reverse panoramic radiograph on lambdoid suture for age estimation. Quant Imaging Med Surg. 2015;5(4):519–523.

Retroactive permission to use the image was sought from and granted by Editorial office, Quantitative Imaging in Medicine and Surgery

The authors affirm their commitment to upholding ethical standards in academic publishing and sincerely apologize for this unintentional error. Measures have been taken to ensure that such an oversight does not recur in future publications.

Corresponding Author: Dr Mahima V Guledgud, Professor, Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysore

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

Call for Papers / Article Submission

Indian Journal of Forensic Medicine & Toxicology has commenced publication since 2007. IJFMT will be published two times in a year.

Purpose & Scope: Indian Journal of Forensic Medicine & Toxicology is a peer reviewed six monthly Journal. It deals with Forensic Medicine, Forensic Science, Toxicology, DNA fingerprinting, sexual medicine and environmental medicine. It has been assigned International standard serial No. p-0973-9122 and e-0973-9130 **website: www.ijfmt.com**. This journal is also indexed with Index Copernicus (Poland).

The journal encourages research from theoretical perspectives, research reports of evidence based practice as well as praxis research work that focuses on the interface between theory and practice and how each can support the other. In addition, the journal strongly encourages reports of research carried out within or involving countries in the Asia- Pacific region.

Invitation to submit papers:
A general invitation is extended to authors to submit journal papers for publication in IJFMT.

The following guidelines should be noted:

1. The article must be send by E-mail in word only as attachment. Hard copy need not be send.
2. The article should be accompanied by a declaration from all authors that it is an original work and has not been sent to any other journal for publication.
3. References should be in Vancouver style.
4. As a policy matter, journal encourages articles regarding new concepts and new information.

Please submit paper in following format as far as applicable

1. Title
2. Names of authors
3. Your Affiliation (designations with college address), email id
4. Corresponding author- name , designations, address,email id
5. Abstract with key words
6. Introduction or back ground
7. Material and Methods
8. Findings
9. Discussion / Conclusion
10. Conflict of Interest
11. Source of Support
12. Ethical Clearance
13. References in Vancouver style.
14. Word limit 2500-3000 words, MSWORD Format, single file
15. Please. quote references in text by superscripting

See website for all details

Our Contact info:

Our Contact Info:

Institute of Medico-Legal Publications

Logix Office Tower, Unit No. 1704, Logix City Centre Mall
Sector- 32, Noida - 201 301 (Uttar Pradesh)
Ph. +91 120 429 4015
E-mail: editor.ijfmt@gmail.com, Website: www.ijfmt.com

Indian Journal of Forensic Medicine & Toxicology

CALL FOR SUBSCRIPTIONS

About The Journal

Print-ISSN: 0973-9122 Electronic - ISSN: 0973-9130 Frequency: Quarterly

"Indian Journal of Forensic Medicine & Toxicology" is a peer reviewed six monthly Journal. It deals with Forensic Medicine, Forensic Science, Toxicology, DNA fingerprinting, sexual medicine and environmental medicine. It has been assigned International standard serial No. p-0973-9122 and e-0973-9130. The Journal has been assigned RNI No. DELENG/2007/21789.

The journal is covered by EMBASE (Excerpta Medica Database). The journal is also abstracted in Chemical Abstracts (CAS) database (USA.

Journal Title	Print Only
Indian Journal of Forensic Medicine & Toxicology	**INR 12,000**

NOTE FOR SUBSCRIBERS

- Advance payment required by cheque/demand draft in the name of **"Institute of Medico-Legal Publications"** payable at Noida, Uttar Pradesh.
- Cancellation not allowed except for duplicate payment.
- Claim must be made within six months from issue date.
- A free copy can be forwarded on request.

Bank Details

Name of account :	**Institute of Medico-Legal Publications Pvt Ltd**
Bank:	**HDFC Bank**
Branch	Sector-50, Noida-201 301
Account number:	**09307630000146**
Type of Account:	Current Account
MICR Code:	110240113
RTGS/NEFT/IFSC Code:	HDFC0000728

Please quote reference number.

Send all payment to

Institute of Medico-Legal Publications

Logix Office Tower, Unit No. 1704, Logix City Centre Mall
Sector- 32, Noida - 201 301 (Uttar Pradesh), Ph. +91 120 429 4015,E-mail: editor.ijfmt@gmail.com, Website: www.ijfmt.com

Registered with Registrar of Newspapers for India
(Regd. No. DELENG/2007/21789)

Printed: Printpack Electrostat G-2, Eros Apartment, 56, Nehru Place, New Delhi-110019

Published at: Institute of Medico Legal Publications Pvt. Ltd., Logix Office Tower, Unit No. 1704, Logix City Centre Mall, Sector- 32, Noida - 201 301 (Uttar Pradesh) Ph. No: +91 120- 429 4015