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Medicolegal Spectrum of Fatal Firearm Injuries: A Retrospective Autopsy Study from Eastern India

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ABSTRACT

Background: Fatal firearm injuries constitute a major medicolegal challenge owing to the complexity of wound interpretation, reconstruction of events, determination of range of fire, and preservation of forensic evidence.[1–5] Autopsy examination remains the cornerstone for establishing the cause and manner of death in such cases. Data from Eastern India addressing the broader medicolegal spectrum of firearm fatalities remain limited.

Aim: To study the medicolegal spectrum and autopsy characteristics of fatal firearm injuries encountered at a tertiary care centre in Eastern India.

Materials and Methods: A retrospective descriptive autopsy study was conducted on fatal firearm injury cases subjected to medicolegal autopsy at the Department of Forensic Medicine and Toxicology of a tertiary level teaching hospital of eastern India. Twenty-one autopsy cases fulfilling the inclusion criteria were reviewed. Demographic characteristics, manner of death, firearm wound characteristics, range-of-fire indicators, internal findings, and forensic evidence preservation practices were analysed using descriptive statistics.

Results: A total of 21 firearm fatalities were studied. Homicide was the predominant manner of death, accounting for 81.0% of cases, while suicide constituted 4.8%. Nearly one-third of the cases required NHRC-compliant documentation. Projectile recovery was achieved in approximately two-thirds of the cases. Classical range-of-fire indicators such as tattooing, grease collar, abrasion collar, blackening, burning, singeing, and turning-in of body hairs were inconsistently observed. Preservation of forensic evidence, including clothing, gunshot residue samples, control skin, videography, and recovered projectiles, formed an integral component of modern firearm autopsy practice.

Conclusion: Fatal firearm injuries in Eastern India demonstrate considerable medicolegal heterogeneity. Comprehensive autopsy examination combined with meticulous preservation of forensic evidence remains indispensable for accurate reconstruction of firearm deaths and determination of manner of death.

Keywords: *Firearm injuries; Gunshot wounds; Autopsy; Medicolegal spectrum; Gunshot residue; Eastern India.*

INTRODUCTION

Firearm-related fatalities continue to pose significant medicolegal challenges worldwide and remain an important contributor to injury-related mortality.[13,14] Apart from establishing the cause of death, the forensic pathologist is frequently required to reconstruct the sequence of events, determine the manner of death, estimate the range of fire, recover projectiles, and preserve evidence for subsequent ballistic and forensic laboratory examination.[1–7]

Interpretation of firearm injuries depends upon a comprehensive assessment of wound morphology, associated internal injuries, trajectory analysis, and circumstantial evidence.[2,3,22] Classical indicators of range of fire, including blackening, tattooing, burning, singeing, abrasion collars, and grease collars, although well described, may not always be present and require cautious interpretation.[1,22]

Recent advances in forensic protocols, particularly in NHRC-mandated autopsies and custodial deaths, have emphasized the importance of systematic evidence preservation, including collection of gunshot residue (GSR), preservation of skin around entry wounds, videography, radiological imaging, and maintenance of chain of custody.[15,16]

Indian literature on firearm fatalities has largely focused on demographic profiles and wound characteristics.[8–12,23] Studies exploring the broader medicolegal spectrum of firearm deaths, especially from Eastern India, remain scarce.

The present study was therefore undertaken to evaluate the demographic profile, wound characteristics, medicolegal circumstances, range-of-fire indicators, and evidence preservation practices associated with fatal firearm injuries encountered at autopsy.

AIM AND OBJECTIVES

Aim

To study the medicolegal spectrum of fatal firearm injuries encountered at medicolegal autopsy in a tertiary care centre in Eastern India.

Objectives

1. To analyse the demographic profile of victims of fatal firearm injuries.
2. To determine the manner of death in firearm fatalities.
3. To describe the characteristics and anatomical distribution of firearm wounds.
4. To evaluate autopsy indicators useful in assessment of range of fire.
5. To assess forensic evidence preservation practices and associated medicolegal challenges.

MATERIALS AND METHODS

Study Design and Setting

A retrospective descriptive autopsy study was conducted in the Department of Forensic Medicine and Toxicology of a tertiary level teaching hospital of eastern India.

Study Period

The study included medicolegal autopsies performed over the study period extending from **March 2023 to February 2025**, based on the available firearm-related postmortem records.

Study Population

All fatal firearm injury cases subjected to medicolegal autopsy during the study period were reviewed.

Inclusion Criteria

- All autopsy cases in which firearm injury was established as the primary cause of death.
- Cases with complete postmortem documentation permitting assessment of firearm wound characteristics and medicolegal variables.
- NHRC-mandated firearm autopsies and encounter-related firearm deaths.

Exclusion Criteria

- Cases involving non-firearm trauma.
- Cases in which records were grossly incomplete, preventing meaningful analysis.
- Firearm survivors not subjected to autopsy.

Sample Size

A total of **21 fatal firearm injury cases** fulfilled the inclusion criteria and were included in the study.

Data Collection

Data were extracted from:

- Postmortem reports,
- Police requisitions,
- Inquest reports,
- NHRC annexures where applicable,
- Autopsy photographs and videography records,
- Specimen preservation records.

The following variables were recorded:

Demographic Variables

- Age,
- Sex,
- Identity status.

Medicolegal Variables
- Police station,
- Hospital dead/brought dead status,
- Manner of death,
- NHRC involvement,
- Border-related or custodial circumstances.

Firearm Variables
- Number of entry wounds,
- Number of exit wounds,
- Anatomical location of injuries,
- Single versus multiple firearm injuries,
- Projectile recovery.

Range-of-Fire Indicators
- Abrasion collar,
- Grease collar,
- Tattooing,
- Blackening,
- Burning,
- Singeing,
- Turning-in of body hairs,
- Explicit opinion regarding range of fire.

Internal Findings
- Organs injured,
- Skeletal injuries,
- Major vascular involvement,
- Final cause of death.

Evidence Preservation Practices
- Preservation of clothing,
- Gunshot residue (GSR) sampling,
- Preservation of skin around entry wounds,
- Control skin sampling,
- Preservation of bullets/pellets,
- Nail scrapings,
- Blood samples,
- Radiological imaging,
- Videography,
- Histopathological examination.

Statistical Analysis
Data were entered into Microsoft Excel and analysed using descriptive statistical methods.
Categorical variables were expressed as frequencies and percentages.
Continuous variables, where applicable, were expressed as mean and range.
Considering the relatively small sample size and descriptive objectives of the study, inferential statistical tests were not performed.

RESULTS
During the study period, a total of **21 fatal firearm injury cases** were subjected to medicolegal autopsy and included in the analysis.
Homicide emerged as the predominant manner of death, accounting for the vast majority of cases. One case was classified as suicidal in manner, while a small proportion remained undetermined owing to the limitations of available circumstantial evidence.

A substantial proportion of firearm deaths required enhanced medicolegal documentation under NHRC protocols, reflecting the increasing emphasis on transparency and accountability in firearm-related fatalities.
Projectile recovery was achieved in a majority of the cases. Recovered bullets and pellets were appropriately preserved and handed over to investigating agencies for ballistic examination.

Classical external indicators of firearm discharge such as tattooing, grease collars, abrasion collars, blackening, burning, singeing, and turning-in of body hairs were observed variably across the study population. No single indicator was found to be universally present.

The thorax and head constituted the commonest anatomical regions involved, with injuries to vital organs including the heart, lungs, liver, stomach, intestines, and brain contributing significantly to mortality.

Preservation of forensic evidence formed an important component of the autopsy protocol. Along with routine viscera preservation, gunshot residue sampling, preservation of skin surrounding entry wounds, control skin collection, videography, radiological investigations, and maintenance of chain of custody were undertaken in several cases.

Table 1. Demographic and Medicolegal Profile of Fatal Firearm Injury Cases (n = 21)

Variable	Frequency (n)	Percentage (%)
Manner of Death		
Homicidal	17	81.0
Suicidal	1	4.8
Undetermined	2	9.5
Encounter/NHRC-related*	1	4.8
NHRC Documentation		
Present	6	28.6
Absent	15	71.4

*Encounter cases have been included under homicidal deaths for legal classification but are presented separately to highlight their medicolegal significance.

Homicidal firearm injuries constituted the predominant pattern observed in the present study. Approximately one-third of the cases required NHRC-compliant documentation, including videography and enhanced evidence preservation.

Table 2. Characteristics of Firearm Injuries and Projectile Recovery (n = 21)

Variable	Frequency (n)	Percentage (%)
Projectile recovered	14	66.7
Projectile not recovered	2	9.5
Recovery status not documented	5	23.8
Single firearm injury	13	61.9
Multiple firearm injuries	8	38.1
Thoracic involvement	9	42.9
Cranio-cerebral involvement	4	19.0
Abdominal involvement	3	14.3
Extremity involvement	3	14.3
Multiple anatomical regions	2	9.5

Projectile recovery was achieved in approximately two-thirds of the cases. The thorax was the most frequently involved anatomical region, followed by the head and neck region. Multiple firearm injuries were encountered in more than one-third of the victims.

Table 3. Range-of-Fire Indicators Observed at Autopsy (n = 21)

Indicator	Frequency (n)	Percentage (%)
Turning-in of body hairs	3	14.3
Tattooing	1	4.8
Grease collar	2	9.5
Abrasion collar	1	4.8
Blackening	2	9.5
Burning	1	4.8
Singeing	1	4.8

Indicator	Frequency (n)	Percentage (%)
Explicit distant-shot opinion	3	14.3
Explicit close/intermediate-shot opinion	2	9.5

Classical indicators of firearm discharge were inconsistently encountered. No single external sign reliably predicted the range of fire in all cases. Interpretation of range therefore required integration of wound morphology, internal trajectory, circumstantial information, and laboratory findings.

Table 4. Evidence Preservation Practices in Fatal Firearm Autopsies (n = 21)

Evidence Preserved	Frequency (n)	Percentage (%)
Clothing	21	100
Skin around entry wound	11	52.4
Blood samples/gauze	12	57.1
Nail scrapings/cuttings	10	47.6
Control skin	8	38.1
GSR sampling	9	42.9
Videography	7	33.3
X-ray examination	3	14.3
Histopathological examination	1	4.8

Preservation of clothing was universal in the present series. More advanced forensic practices, including GSR collection, videography, and preservation of control skin, were particularly evident in NHRC and recent-format autopsies.

DISCUSSION

In our experience, firearm fatalities encountered during medicolegal autopsy often extended beyond routine wound interpretation and required careful consideration of evidentiary and procedural issues. Unlike conventional firearm studies that predominantly focus on demographic characteristics and wound morphology, the present series incorporated evidence preservation practices and NHRC-compliant procedures as important forensic variables.[8–12,23]

Homicide emerged as the predominant manner of death, accounting for more than four-fifths of the cases. Similar observations have been reported in several Indian autopsy-based firearm studies, reflecting the predominance of interpersonal violence in fatal firearm injuries.[8–12,23]

Projectile recovery was achieved in approximately two-thirds of the cases. Retrieval and preservation of bullets and pellets remain crucial for ballistic examination and reconstruction of firearm events.[1,2,22] The high recovery rate observed in the present study underscores the importance of meticulous dissection during medicolegal autopsy.

Injuries to the heart, lungs, and major vessels resulted in rapid exsanguination and accounted for a substantial proportion of fatalities, consistent with previous autopsy observations.[10,11] Cranio-cerebral injuries represented the second most common fatal pattern and were associated with extensive skull fractures and devastating brain damage.

In the present series, classical range indicators were observed inconsistently, suggesting that estimation of firing distance should not rely on any single autopsy sign. Tattooing, blackening, grease collars, burning, singeing, and turning-in of body hairs were documented only in selected cases. This observation reinforces the principle that no individual sign should be interpreted in isolation while estimating the range of fire.[1,22]

Recent cases demonstrated greater use of evidence preservation measures such as GSR collection and videographic documentation, reflecting changing medicolegal expectations. Clothing preservation, GSR sampling, control skin collection, videographic documentation, and radiological imaging were increasingly employed in recent cases and NHRC-mandated autopsies. Such practices strengthen the evidentiary value of postmortem examination and facilitate subsequent laboratory analyses.[15,16,19]

The presence of NHRC-compliant firearm autopsies in nearly one-third of the series reflects evolving medicolegal standards aimed at enhancing transparency and accountability in deaths occurring under sensitive circumstances.[15,16]

LIMITATIONS

The study was retrospective in nature and involved a relatively small sample size from a single tertiary care centre. Certain variables were unavailable in older records owing to differences in reporting formats over time. Consequently, the findings should be interpreted as descriptive observations rather than representative estimates of firearm mortality patterns in the general population.

CONCLUSION

Fatal firearm injuries in Eastern India exhibit considerable medicolegal heterogeneity. Homicide constituted the predominant manner of death, while thoracic and cranio-cerebral injuries represented the major fatal patterns. Classical range-of-fire indicators were variably expressed and required cautious interpretation in conjunction with autopsy findings and circumstantial evidence.

Meticulous autopsy examination, systematic preservation of forensic evidence, and adherence to contemporary medicolegal protocols remain indispensable for accurate reconstruction of firearm deaths and determination of the cause and manner of death. The present study highlights the evolving role of the forensic pathologist in integrating traditional wound ballistics with modern evidence-based practices in firearm fatality investigations.

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