

Study of Physical and Biological Evidences on Clothes - An Autopsy based Cross-Sectional Study in a Tertiary Care Hospital

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Received: 13 Jun 2026/ Revised: 14 Jul 2026/ Accepted: 15 Aug 2026

ABSTRACT

Background: In medico-legal autopsies, external and internal body injuries dominate the determination of the cause and manner of death. However, clothing worn by the deceased at the time of an incident represents an immediate extension of the crime scene and acts as a vital repository of physical and biological trace evidence. To ascertain the role of clothing evidence in opining on the cause/manner of death, individual identification, and place of occurrence, while correlating these findings directly with internal autopsy lesions.

Methods: An autopsy-based cross-sectional study was conducted over a 24 months period (January 2024 to December 2025). A total of 2,798 autopsies were screened, out of which 252 cases presenting with medicolegally significant physical or biological evidence on clothing were analysed.

Results: Out of 2,798 autopsies, clothing was intact or brought in 2,184 cases (78.05%). Medico-legally significant evidence was recovered from 252 cases (9.01%). Bloodstains were the most common biological evidence (40.86%, 103 cases), while soil/wet conditions led physical evidence findings (15.48%, 39 cases). Pocket contents and clothing details aided the identification of the deceased in 29.47% (84 out of 285 unknown cases). Clothing evidence perfectly correlated with internal autopsy findings in 90.08% (227 cases).

Conclusion: Systematic examination of clothing provides invaluable corroborative and definitive evidence regarding the trajectory of weapons, mechanics of impact, scene characteristics, and personal identity. It must be executed as a mandatory, non-cursory phase of forensic post-mortem protocols.

Key-words: Autopsy, Biological Evidences, Clothes, Crime Scene Reconstruction, Physical Evidences

INTRODUCTION

Clothing serves as an intimate boundary between the human body and the external environment. When an offense or unnatural event occurs, clothing is directly involved and inevitably retains trace materials.

The collection and analysis of these materials are deeply rooted in Edmond Locard's Exchange Principle, which posits that every contact leaves a trace.^[1] Common forensic traces deposited on textiles include bloodstains, seminal fluid, saliva, vomitus, hair, textile fibers, glass fragments, soil, and grease.^[2-5]

In routine forensic practice, clothing is occasionally dismissed with a cursory glance or removed prematurely during clinical resuscitation in hospitals, leading to the loss of critical trace markers. Comprehensive examination of clothing assists the forensic surgeon in Reconstructing the sequence of events at the scene of occurrence, Differentiating homicidal, suicidal, and

How to cite this article

Thousifahamed B, Gokulakrishnan A, Janani S, Priyatharshini K, Balasubramanian S. Study of Physical and Biological Evidences on Clothes - An Autopsy based Cross-Sectional Study in a Tertiary Care Hospital. SSR Inst Int J Life Sci., 2026; 12(5): 10760-10766.



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accidental mechanics (e.g., assessing if a garment was folded or multi-layered during a stab event),^[2] Confirming individual identity via structural tailor markings, laundry labels, and pocket contents^[6-8] and Ascertaining whether injuries are antemortem or postmortem (e.g., vertical salivary dribbling in hanging cases).^[9]

Very few structured cross-sectional studies exist regarding the statistical correlation between clothing artifacts and internal autopsy findings.^[10,11] This research highlights the vital role clothing evidence plays in the administration of medical justice.

Despite the established importance of clothing evidence in forensic investigations, systematic evaluation of garment damage in relation to internal autopsy findings remains limited, particularly in routine medico-legal practice. Careful examination of clothing can provide valuable information regarding the nature, direction, and severity of trauma, while pocket contents, labels, stains, fibres, and other textile-associated materials may assist in establishing identity and reconstructing the circumstances surrounding death. However, inadequate documentation, premature removal, or improper handling of clothing may result in the loss of important forensic information. Therefore, the present study was undertaken to evaluate the relationship between external garment damage and internal autopsy findings, assess the anatomical correlation of clothing injuries with underlying trauma, and determine the forensic value of clothing and associated trace evidence in establishing identity and manner of death.

MATERIALS AND METHODS

Study Design and Population- This cross-sectional study was carried out at the Department of Forensic Medicine and Toxicology mortuary, Government Stanley Medical College and Hospital, Chennai, India, over a 24-month window from January 2024 to December 2025. Prior institutional ethical clearance was obtained.

Inclusion Criteria- All medico-legal autopsies presenting with intact clothing or clothing brought along by police officers with an official seizure report, where physical or biological evidence was present and carried diagnostic weight.

Exclusion Criteria- All cases of death resulting from poisoning (due to standard chemical analysis protocols requiring immediate viscera preservation) and firearm fatalities (where clothing is directly forwarded for specialized Gun Shot Residue analysis under separate forensic ballistics mandates).

Data Collection Protocol- Information regarding history, place of occurrence, hospitalization, and clinical treatment was extracted from Police Inquest Form 86. Garments were first examined in situ to observe spatial correlations between apparel damage and external surface wounds. Following removal, garments were hung on separate coat hangers to dry at ambient room temperature, preventing microbial decay and artificial heat degradation. Evidence locations were mapped on a standardized proforma and photographed using standard colour and dimension scales.

Laboratory Testing of Evidence:

Bloodstains: Screened via Hemastix strip tests (peroxidase-like activity confirmation).

Seminal Stains: Verified using a Professional Semen Kit (Acid Phosphatase detection).

Salivary Stains: Identified via the Phadebas press test (amylase enzymatic activity).

Physical Evidence (Soil, Glass shards, Tyre marks, Grease): Evaluated macroscopically and microscopically under controlled laboratory lighting.

Statistical Analysis- Collected variables were tabulated in MS Excel and statistically analysed using Epi Info software. Categorical metrics were expressed as frequencies and percentages, and correlation logic was substantiated using Chi-Square tests where relevant.

Ethical Approval: The study was approved by the Institutional Ethics Committee (IEC), Government Stanley Medical College & Hospital, Chennai-01. Ethical approval was granted at the IEC meeting held on 12 December 2023. The study was conducted in accordance with the ethical requirements and institutional guidelines of the IEC. Any changes in the study procedure or protocol were to be reported to the IEC as required.



RESULTS

Out of 2,798 total autopsies conducted during the study timeframe, 2,184 cases arrived with intact or accompanying garments. A subset of 252 cases demonstrated forensic physical or biological markers on the clothes.

Case Distribution and Prevalence of Clothing Evidence:
Out of a total sample size of n=2798 autopsies conducted during the study timeframe, garments were present *in*

situ or accompanied the body in 2,184 cases (78.05%). Conversely, clothes were missing or had been removed pre-mortuary (e.g., during clinical resuscitation or emergency interventions) in 614 cases (21.95%). A specific targeted cohort of n=252 cases (9.01% of total autopsies) demonstrated forensically significant physical or biological markers on the clothes and was selected for detailed evaluation (Table 1).

Table 1: Case Distribution and Prevalence of Clothing Evidence

Parameter Evaluated	Total Number of cases	Percentage (%)
Total Autopsies Done	2798	100
Clothes Present In Situ / Accompanying	2184	78.05
Clothes Missing / Removed Pre-Mortuary	614	21.95
Cases with Significant Clothes Evidence	252	9.01

Various types of Physical Evidences on the Clothes:
Within the evidence cohort (n=252), soil or wetness was the most frequent physical marker, noted in 39 cases (15.48%). Tears or cuts were observed in 24 cases (9.52%), followed closely by grease stains in 23 cases (9.12%). Burnt marks or distinct chemical odors were

recovered in 10 cases (3.97%), tire marks in 6 cases (2.39%), and glass shards in 4 cases (1.59%). More than half of this cohort (145 cases; 57.53%) presented with no physical evidence, carrying purely biological markers instead (Table 2).

Table 2: Various types of Physical Evidences on the Clothes

Various types of Physical Evidences	Number of Cases	Percentage (%)
Tears/ Cut	24	09.52
Soil/Wet	39	15.48
Grease Stain	23	09.12
Glass Shards	04	01.59
Burnt marks/ Odour from clothes	10	03.97
Tyre marks	06	02.39
Others	01	00.40
No physical Evidences	145	57.53

Various types of Biological Evidences on Clothes: Within the evidence cohort (n=252), bloodstains were overwhelmingly the most prevalent biological marker, detected in 103 cases (40.86%). Salivary stains were identified in 39 cases (15.48%), and seminal stains were

confirmed in 18 cases (7.14%). Minor biological traces included vomitus (6 cases; 2.39%) and fecal stains (4 cases; 1.58%). No biological evidence was present in 82 cases (32.53%), which instead relied entirely on physical trace configurations (Table 3).

**Table 3:** Various types of Biological Evidences on Clothes

Various type of Biological Evidences	Number of Cases	Percentage (%)
Salivary Stain	39	15.48
Blood stain	103	40.86
Seminal Stain	18	07.14
Vomit	06	02.39
Fecal Stain	04	01.58
Others	0	0
No Biological Evidences	82	32.53

Diagnostic and Correlative Value of Garment Analysis: When matching clothing artifacts against somatic injuries (n=252), a strong anatomical correlation was established in 182 cases (72.22%), where the garment damage or stains aligned directly with physical wounds. Conversely, the evidence failed to match physical wounds in 24 cases (9.52%). In 46 cases (18.26%), clothing evidence provided vital data despite the complete absence of physical body injuries. Regarding the manner of death categorization (n=252), accidental fatalities comprised the largest group within the evaluated cohort with 99 cases (39.29%), followed by suicidal deaths (83 cases; 32.93%) and

homicidal deaths (53 cases; 21.03%). Natural causes accounted for the remaining 17 cases (6.75%). A Chi-Square test of independence confirmed a highly significant association between the distribution of specific clothing evidence profiles (physical vs. biological) and the specific manner of death ($\chi^2=41.68$, $df=3$, $p<0.0001$).

Furthermore, out of n=285 total unidentified profile bodies brought to the mortuary during this period, an examination of pocket contents, personal items, or specific clothing markers successfully established positive individual identity in 84 cases (29.47%) (Table 4).

Table 4: Diagnostic and Correlative Value of Garment Analysis

Correlative Outcome Measure	Finding Details	Case Matches	Percentage (%)
Anatomical Injury Correlation	Evidence matches physical wounds	182	72.22%
	Evidence does not match wounds	24	9.52%
	No physical body injuries	46	18.26%
Manner of Death Categorization	Accidental Deaths	99	39.29%
	Suicidal Deaths	83	32.93%
	Homicidal Deaths	53	21.03%
	Natural Causes	17	6.75%
Unknown Profile Identification	Positive identity via clothes/pockets	84	29.47% (of 285 unknown cases)

The evidentiary value of clothing was further evaluated by correlating garment findings with independent medico-legal and investigational parameters. Within the study cohort, accidental deaths constituted 39.29% (99 cases), suicidal deaths 32.93% (83 cases), homicidal

deaths 21.03% (53 cases), and natural deaths 6.75% (17 cases). Among the 252 cases evaluated for history and scene matching, 90.08% (227 cases) demonstrated clothing findings consistent with the documented police history or crime-scene profile.

Anatomical concordance was observed in 72.22% (182 cases), where physical or biological traces on clothing corresponded directly with underlying somatic injuries. In 9.52% (24 cases), clothing stains or tears did not correspond with identified bodily injuries, while 18.26% (46 cases) had no external somatic trauma, including cases such as hanging or drowning. Among 285 unidentified bodies, pocket contents, personal effects, and garment labels contributed to positive identification in 84 cases (29.47%). Overall, the structural correlation between textile alterations and internal autopsy findings was 90.08% (227 cases).

DISCUSSION

In this 24-month study encompassing $n=2798$ autopsies, garments accompanied the body or were present *in situ* in 78.05% of cases, while they were completely missing or stripped pre-mortuary in 21.95% of cases. This substantial loss of nearly one-fifth of potential textile evidence is primarily attributed to emergency clinical resuscitation at tertiary care centers or aggressive clothing removal by first responders at crime scenes.^[4] This finding strongly mirrors standard forensic observations where lifesaving protocols inadvertently prioritize systemic access over trace evidence preservation, pointing to an urgent need for standardized training for emergency medical staff regarding Locard's Exchange Principle.^[1]

Physical traces were definitively isolated in 42.47% of the critical evidence cohort ($n=252$), with soil and wetness emerging as the most dominant markers (15.48%). This high incidence of soil contamination directly reflects Chennai's outdoor crime scene profiles, transit accidents, and open-air exposures. Mechanical defects, specifically cuts and tears (9.52%), and grease stains (9.12%) served as highly reliable physical indicators of mechanical trauma.^[12,13] These structural changes are vital for mapping impact vectors, identifying weapon profiles, and pinpointing vehicle contact points in hit-and-run fatalities.

Biological fluid deposition represents a cornerstone of forensic garment analysis, presenting in 67.47% of the study cohort. Bloodstains were overwhelmingly the most prevalent biological marker (40.86%), which acts as a reliable indicator of severe somatic disruption. The presence of salivary stains in 15.48% of cases carries profound diagnostic weight, particularly in differentiating

true suspension asphyxia from post-mortem suspension. Saliva dripping onto a garment provides clear proof of active physiological secretion,^[14,15] which helps confirm that an injury occurred before death.^[16] Seminal stains (7.14%) and minor markers like vomitus (2.39%) provided indispensable corroborative values in suspected sexual offenses^[4] and cases involving localized chemical toxicities or severe systemic shock.

The statistical power of this research is highlighted by the exceptional anatomical injury correlation rate of 72.22% ($n=182$), where structural textile damage or fluid stains perfectly aligned with underlying bodily wounds. This high concordance rate confirms that clothing acts as a reliable physical mirror of somatic trauma. However, the 9.52% discordance rate (where clothing marks failed to match internal injuries) is equally critical. In practice, this discrepancy serves as a red flag for the manipulation of a crime scene, post-mortem redressing, or the secondary movement of a body after death.

Furthermore, in 18.26% of cases, garments provided crucial diagnostic clues despite a complete absence of external somatic trauma. This pattern is typically seen in clean hangings, sub-surface drowning, or specific types of asphyxiation where the body remains unmarked but the clothing captures essential chemical or physiological trace evidence.^[17]

The distribution of manner of death within our cohort—dominated by accidental fatalities (39.29%), followed by suicidal (32.93%) and homicidal deaths (21.03%) demonstrates a strong, statistically significant association with the specific evidence profile found on the clothing ($\chi^2=41.68$, $df=3$, $p<0.0001$). This confirms that physical versus biological trace patterns do not distribute randomly; rather, they are strongly shaped by the mechanics of the fatal event.^[18]

Finally, our findings show a high rate of autopsy coherence (90.08%), demonstrating that combining textile evaluation with internal pathological findings provides a much clearer picture of how an injury occurred. This utility is further illustrated by the successful identification of 29.47% ($n=84$ out of 285) of previously unidentified bodies through pocket contents, personal effects, and unique tailor markings, proving that meticulous garment inspection can restore identity to unknown individuals when biological profiles alone cannot.^[15,19]

CONCLUSIONS

This study demonstrates that meticulous garment analysis is essential for accurate forensic reconstruction, showing 90.08% structural coherence with internal autopsy findings. Clothing evidence served as a reliable physical and biological indicator of somatic trauma, with a 72.22% direct anatomical injury correlation and a highly significant association with specific manners of death. Furthermore, examination of pocket contents and textile markers contributed to individual identification in 29.47% of unknown profiles. These findings highlight that premature removal or inadequate preservation of clothing can compromise medico-legal investigations and the pursuit of medical justice. Systematic clothing preservation should therefore be regarded as a critical component of post-mortem examination rather than a routine procedural step. Future efforts should focus on standardized inter-agency training for emergency medical technicians and first responders to minimize destruction of textile evidence during resuscitation. Integration of digital mapping and advanced analytical methods for garment damage may further improve injury correlation, geographical tracking, and individual identification in complex forensic investigations.

ACKNOWLEDGMENTS

The author acknowledges the institutional support provided by the Department of Forensic Medicine and Toxicology.

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