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ORIGINAL ARTICLE

CORRELATION OF HEIGHT AND MAXIMUM OVERHEAD REACH: FORENSIC IMPLICATIONS FROM A STUDY OF YOUNG ADULTS IN SRI LANKA

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ABSTRACT

Introduction: Hanging is a common method of suicide encountered in routine forensic practice, and the ability of the victim to access the suspension point is a crucial consideration during the death investigation. Establishing a correlation between an individual's height and maximum overhead reach (MOR) can provide supportive evidence when determining the circumstances of death in suspected hanging cases.

Objectives: This study aimed to establish a correlation between height and MOR in a cohort of Sri Lankan young adults.

Methods: A cross-sectional study was conducted among 189 university students (86 males, 103 females) aged 22–26 years, selected through simple random sampling. Standing height was measured barefoot from heel to vertex using a stadiometer. MOR was measured by marking the highest point attained when the participant, standing on tiptoes on one foot, extended the opposite arm overhead to 180°. Measurements were recorded thrice and averaged. A regression equation was formulated to assess the relationship between height and MOR.

Results: The mean height was 168.9 cm for males and 157.1 cm for females, with corresponding mean MORs of 228.9 cm and 213.6 cm. A strong positive correlation was observed between height (H) and MOR in both sexes (Pearson's $r=0.922$ in males, 0.895 in females, $p<0.001$). Regression models demonstrated high predictive accuracy: $MOR=1.493H-23.270$ (males, $R^2=0.850$) and $MOR=0.931H+67.492$ (females, $R^2=0.800$). A multiple regression model incorporating height and age (A) yielded the equation $MOR=1.240H-0.604A+33.678$ (adjusted $R^2=0.891$, $p<0.001$).

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Conclusion: The regression models derived can aid forensic practitioners in assessing whether a victim could reach the suspension point in cases of hanging, although findings should be interpreted alongside circumstantial and autopsy evidence.

Keywords: Hanging; maximum overhead reach; suicide

INTRODUCTION

Hanging is a common presentation in routine forensic practice, with self-suspensions being the commonest¹. The circumstances of death will be suicidal in most cases, but the possibility of postmortem suspension, accidental hanging, and homicidal hanging needs to be excluded^{2,3}. It was the preferred method of suicide in Sri Lanka before 1960, but was overtaken later by agrochemical poisoning^{4,5}.

In cases of suicidal hanging, the person's height and the height from the ground level to the point of suspension are important factors to determine if the person was able to reach the point where the ligature is suspended from. In a typical case, the victim would be using a ligature such as a rolled bed sheet or saree, a wire, string, belt, necktie, or other rope-like objects¹. One end of the ligature will be attached to a higher point, like a ceiling beam or a ceiling fan, while the other end will be placed around the victim's neck, formed into a fixed loop or slip knot. The victim would use a supporting surface, such as a chair or desk, to reach the point where the upper end of the ligature is attached, and subsequently, would jump off or kick the supporting surface away, as in the case of a chair. Ideally, the height to the point of suspension from the ground level needs to be equal to or less than the sum of the height of the support and the maximum overhead reach (MOR) of the person. Otherwise, a suspicion of postmortem suspension or homicidal hanging may arise.

OBJECTIVES

This study aimed to derive regression relationships between the height (H), age (A), and MOR in a Sri Lankan young adult population.

METHODS

The ethical approval for this study was granted by the Ethics Review Committee of the Faculty of Medicine, University of Peradeniya, Sri Lanka (2021/EC/48). In this study, a simple random sampling technique was used to recruit voluntary young adults, with informed written

consent, among the undergraduates of the University of Peradeniya, Peradeniya, Sri Lanka. Individuals with musculoskeletal deformities or growth disorders, a history of trauma to long bones or vertebrae, absence of toes or fingers or any other condition/disease that may affect the stature and MOR were excluded.

The age and the sex of each subject were documented. The height measurements were recorded in two steps. First, the standing height of the subject was measured from the bare heel flat on the ground to the vertex of the head in centimetres (Figure 1a) using a stadiometer. During this measurement, participants stood barefoot in an upright position with their heels together, back straight, arms relaxed at the sides, and the head positioned in the Frankfurt horizontal plane.

Then the measurement of the point that attained their MOR was marked (Figure 1b). For this measurement, the participant stood adjacent to a vertical wall and was instructed to reach the highest possible point with one hand. The participants were asked to lift from their toes in one foot, bending towards that foot slightly with their hips, extending the opposite arm, ideally the dominant arm, to 180 degrees above their head. The arm was fully extended with the elbow straight, and fingers extended, and the highest point reached by the tip of the middle finger was marked on the wall. Participants were instructed not to jump during this manoeuvre.

The distance from the ground level to the marked point of MOR was measured vertically using a standard 150 cm tailor's tape fixed to a wall. Since the height exceeded the length of the tape, the measurement was taken in two sequential segments and added together to obtain the total distance. Both the standing height and MOR measurements were recorded three times for each participant, and the average value was used for analysis in order to minimize measurement error.

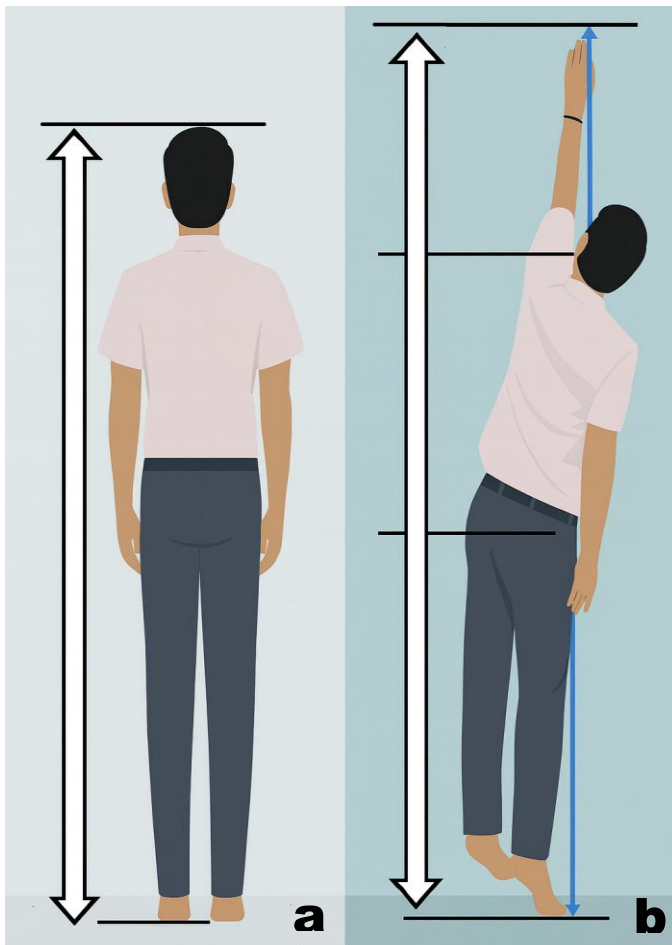


Figure 1: Measurement of the standing height (a) and maximum overhead reach (b).

Collected data was analysed using IBM SPSS Statistics version 26. Normality of the variables was assessed using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. Although the Shapiro–Wilk test indicated statistically significant deviations from normality, visual inspection suggested approximate normal distribution. Therefore, Pearson’s correlation coefficients were calculated to assess the relationship between MOR, height, and age. Mean MORs were compared using the independent sample t-test. Simple and multiple linear regression analyses were performed to derive predictive equations. Independence of residuals was evaluated using the Durbin–Watson statistic.

RESULTS

A total of 189 individuals participated in the study, with 86 males (45.5%) and 103 females (54.5%). The ages ranged from 22 years to 26 years, with a mean age of 24.0 years. The mean height was 162.4 cm, with the mean height of males being 168.9 cm and 157.1 cm in females. The MOR for males ranged from 200.8 cm to 252.0 cm, with a mean of 228.9 cm. In females, the MOR ranged from 191.8 cm to 232.4 cm with a mean of 213.6 cm. For both sexes, the mean MOR was 220.6 cm. Among the participants, 179 (94.7%) were right-handed while 10 (5.3%) were left-handed.

Table 1: Correlations of height and age with MOR

Variable		Correlation coefficient (Pearson’s r)	p-value
Height	Both sexes	0.942	<0.001
	Male	0.922	<0.001
	Female	0.895	<0.001
Age	Both sexes	-0.046	0.532
	Male	-0.110	0.314
	Female	-0.075	0.453

Pearson’s correlation analysis (Table 1) demonstrated a strong positive correlation between height and maximum overhead reach (MOR) in both sexes ($r=0.942$, $p<0.001$), as well as in males ($r=0.922$, $p<0.001$) and females ($r=0.895$, $p<0.001$). Age showed weak negative correlations with MOR, which was not statistically significant in the overall sample ($r=-0.046$, $p=0.532$) or when males ($r=-0.110$, $p=0.314$) and females ($r=0.075$, $p=0.453$) were analysed separately.

When the independent sample t-test was used, there was a statistically significant difference in the mean MOR between males and females ($p<0.001$). But between the right- and left-handers, there was no statistically significant difference ($p=0.096$) in mean MOR.

Table 2: Simple regression formulae to calculate MOR from height (H)

Sex	R ²	p-value	Regression formula
Both sexes	0.888	<0.001	1.239H+19.349
Male	0.850	<0.001	1.493H-23.270
Female	0.800	<0.001	0.931H+67.492

Simple linear regression equations were derived to calculate MOR from height (Table 2). When both sexes were considered, simple regression analysis yielded an R² value of 0.888, indicating that this model explains 88.8% of the variation of the variable around the mean. When sexes were considered separately, higher R² values were observed, with 0.850 for males and 0.800 for females. All the derived models were statistically significant (p<0.001).

Furthermore, an attempt was made to formulate a multiple linear regression formula, combining the variables age, sex, handedness, and height to calculate MOR. On analysis, it was revealed that when all variables were considered, the adjusted R² was 0.891. Height was the strongest predictor of MOR (β=0.943, p<0.001), while age showed a statistically significant but small negative association (β=-0.059, p=0.016). However, the variables sex (p=0.159) and handedness (p=0.749) did not provide a statistically significant contribution to the model. Therefore, a revised regression model with age and height as independent variables was considered. A multiple regression model incorporating H and A yielded the equation MOR=1.240H-0.604A+33.678 (adjusted R²=0.891, p<0.001). Residual analysis demonstrated no major violations of linear regression assumptions. Standardized residuals were within acceptable limits. The Durbin-Watson statistic for the main regression model was 1.222, indicating no substantial autocorrelation.

DISCUSSION

Hanging remains one of the most frequently encountered methods of suicide in South Asia and is a major contributor to mortality among young adults worldwide. Globally, suicide ranks as the fourth leading cause of death among individuals aged 15–29 years, with hanging representing a significant proportion of these deaths^{6,7}. Sri Lankan data show that 13–34% of suicides are due to hanging, with substantial contributions from the 21–30 year age group^{6,8}. The present study focused on young adults within this demographic, a group that accounted for more than one-fifth of suicides by hanging reported nationally in 2022⁹.

In forensic practice, assessing the feasibility of self-suspension is a critical component in determining the manner of death in suspected hanging. Reaching the ligature suspension point is essential in suicidal hanging¹⁰, and when the height of the suspension point exceeds MOR, questions may arise regarding postmortem suspension, accidental circumstances, or homicidal involvement. Quantifying MOR, therefore, provides an objective parameter that can aid case interpretation.

The present study demonstrates a strong, statistically significant positive correlation between height and MOR in both males and females. Height accounted for a considerable proportion of the variance in MOR, with sex-specific equations further improving predictive accuracy.

The regression formulae derived in this study can be utilised by forensic investigators when the deceased's height is known, but MOR cannot be measured directly, such as in decomposed or skeletal remains, or cases where direct measurement at the scene is not feasible. When both height and age are available, a multiple regression model provides an alternative equation with similar predictive strength. These formulae, with circumstantial and autopsy evidence, provide a basis for evaluating whether an individual could reasonably have reached the point of ligature suspension.

In a similar study by Sikary et al.¹⁰ in North India, the equation for all participants was $MOR=1.46H+0.02$, while sex-specific equations were $MOR=1.40H+11.22$ for males and $MOR=1.22H+33.34$ for females. The present study also demonstrated similar linear relationships between height and MOR, although the regression coefficients differed slightly. For males, the slope observed in the present study (1.493) was slightly higher than that reported by Sikary et al.¹⁰, whereas the female slope (0.931) was lower. These differences may reflect anthropometric variations between populations or differences in measurement techniques.

Although MOR can be measured directly during autopsy, it is not always practical due to rigour mortis, decomposition, or incomplete remains. In addition, the posture adopted during ligature placement in hanging may involve movements such as standing on tiptoes or reaching with one arm while maintaining balance. The derived regression equations can be used as supportive tools and should be interpreted alongside scene findings, autopsy observations, and circumstantial evidence.

LIMITATIONS

The participants were limited to university students aged 22–26 years, representing a relatively narrow age range of young adults with skeletal maturity. Furthermore, the intercept values observed in the simple regression equations represent theoretical values when the independent variables are zero. These are not physiologically meaningful, as a height of zero is not possible, but are statistical parameters required to achieve the best fit of the regression model within the observed data range. Therefore, the regression equations derived in this study may not be directly generalizable to individuals of other age ranges. The study population consisted of a relatively homogeneous group, which may not fully represent the general population. Although the measurement protocol attempted to simulate a realistic reaching posture, the actual height at which a ligature can be tied in real-life hanging scenarios may vary depending

on body posture, balance, and environmental factors. Therefore, the regression equations should be interpreted as approximate estimates rather than precise values.

CONCLUSION

The regression models derived can aid forensic practitioners in assessing whether a victim could reach the suspension point in cases of hanging, although findings should be interpreted alongside circumstantial and autopsy evidence.

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CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

DISCLOSURE

ANV and EMKBE are members of the Editorial Board of the Sri Lanka Journal of Forensic Medicine, Science & Law. Therefore, they did not participate in any way in the publication/decision-making process of this submission, as per journal policy.

ETHICAL ISSUES

The ethical approval for this study was granted by the Ethics Review Committee, Faculty of Medicine, University of Peradeniya, Sri Lanka (Ref. No: 2021/EC/48). The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

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None

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ORIGINAL ARTICLE

PATTERNS OF INJURIES IN PEDESTRIAN ROAD TRAFFIC ACCIDENTS: A COMPARATIVE ANALYSIS OF DECEASED AND SURVIVING VICTIMS ADMITTED TO THE TEACHING HOSPITAL, KARAPITIYA, SRI LANKA

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ABSTRACT

Introduction: Pedestrian road traffic injuries represent a significant public health and medico-legal concern in Sri Lanka. Understanding injury patterns and mechanisms among pedestrian victims is essential for prevention strategies, trauma management, and forensic evaluation.

Methods: A retrospective observational study was conducted using medico-legal examination forms (MLEFs) and post-mortem reports (PMRs) of pedestrians admitted to Teaching Hospital Karapitiya, Sri Lanka, from 2023 to 2024. Victims were categorized into deceased and survivors. Demographic characteristics, vehicle types involved, injury patterns, mechanisms of injury (ground impact, primary impact), and type of death were analyzed descriptively.

Results: A total of 234 pedestrian victims were included, comprising 154 survivors (65.8%) and 80 deceased (34.2%). Males constituted the majority of both survivors and fatalities. Among deceased pedestrians, the 41-60 years age group was the most affected, while the 21- 40 years age group predominated among survivors. Ground impact injuries were significantly more common among deceased victims and were particularly frequent in on- the-spot deaths. Survivors more commonly sustained extremity injuries, whereas fatalities predominantly involved severe head injuries, including skull fractures and intracranial hemorrhages. Motorcycles were the most frequently involved vehicles in both groups. Delayed deaths were commonly observed following hospital admission, particularly among patients who had undergone surgical intervention for head injuries.

Conclusion: Distinct injury patterns were observed between surviving and deceased pedestrian victims. Ground impact injuries (tertiary impact) and severe head trauma were strongly associated with fatal outcomes, while survivors more frequently sustained non- fatal extremity injuries. These findings emphasize the importance of mechanism-

based injury assessment in medico-legal investigations and highlight the need for targeted preventive strategies to reduce pedestrian mortality in Sri Lanka.

Keywords: *Ground impact injuries; pedestrians; road traffic accidents*

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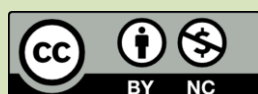
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INTRODUCTION

Road traffic accidents (RTAs) are a major cause of morbidity and mortality among pedestrians, representing one of the most vulnerable road user groups. Due to direct exposure to vehicle collisions, pedestrians are at high risk of sustaining severe or fatal injuries. According to World Health Organization data, vulnerable road users- including pedestrians, cyclists, and motorcyclists account for more than half of global road traffic deaths, with pedestrians alone contributing 23% of fatalities¹.

In Sri Lanka, pedestrian fatalities continue to constitute a substantial proportion of road traffic deaths. In 2022, pedestrians accounted for nearly one-third of all road traffic fatalities, reflecting a significant public health and medico-legal burden. Pedestrian injuries commonly result from a combination of primary impact and secondary injuries (ground impact/tertiary impact injuries), producing complex injury patterns involving the head, thorax, abdomen, and extremities^{2,3}.

Analysis of the injury patterns is essential not only for improving trauma care and prevention strategies but also for medico-legal reconstruction of accident mechanisms. Differentiating primary impact injuries from ground impact injuries assists in understanding vehicle speed, point of contact, and pedestrian position at the time of collision. Such analysis is important in determining liability, assessing negligence, and corroborating eyewitness accounts⁴⁻⁶.

OBJECTIVES

This study aimed to comparatively analyze injury patterns among deceased and surviving pedestrian victims admitted to Teaching Hospital, Karapitiya, Sri Lanka, with emphasis on injury mechanisms and medico-legal relevance.

METHODS

This retrospective observational study was conducted at the office of the Judicial Medical Officer, Teaching Hospital Karapitiya. Pedestrian

victims of road traffic accidents examined between 1 December 2023 and 30 August 2024 were included in the study, and a total of 234 pedestrians were analyzed. Data were obtained from Medico -Legal Examination Forms (MLEFs) of surviving victims and Post-Mortem Reports (PMRs) of deceased victims. Inquest records, Police reports, and accompanying medical documents were reviewed where available, to supplement accident- related details.

The inclusion criteria for the study were surviving pedestrians admitted for treatment with completed medico-legal examination records, deceased pedestrians declared dead on arrival or succumbed to injuries post-admission, and underwent a post-mortem examination, especially those with clear eyewitness accounts or CCTV evidence confirming the circumstances of the accident. Cases were excluded when the degree of decomposition prevented meaningful injury assessments. Additionally, cases with incomplete, inadequate, or unclear injury documentation were not included in the analysis.

Ethical approval was obtained from the Ethics Review Committee, Faculty of Medicine, University of Ruhuna (Ref: 2024/P/020 [17.05.2024]), and permission was granted by the relevant judicial medical officers.

Demographic details, vehicle type, mechanism of injury (primary impact and ground impact), injury distribution, and outcome were recorded. Injuries were categorized by anatomical region and type. Data were analyzed descriptively using frequencies and percentages. Statistical analysis was performed using IBM SPSS Statistics version 16, with Chi-square testing applied where appropriate.

RESULTS

A total of 234 pedestrian road traffic injury cases were analysed, of which 154 (65.8%) survived, and 80 (34.2%) succumbed to their injuries (Table 1). Among the deceased, 32 (40.0%) died at the scene, while 48 (60.0%) experienced delayed deaths following hospital

admission. Almost all delayed deaths occurred in patients who had undergone surgical intervention for head injuries. Males constituted the majority of both survivors and deceased victims. Among survivors, males accounted for 102 (66.2%) cases and females 52 (33.8%), while among deceased pedestrians, males comprised 54 (68%) and females 26 (32%). Age distribution differed between outcome groups. The highest proportion of deceased pedestrians belonged to the 41–60-year age group (35.0%), whereas among survivors, the 21–40-year age group predominated (37.7%) (Table 1).

Table 1: Demographic and outcome characteristics of pedestrian road traffic injury victims (n=234)

Characteristic	Survived (n=154)	Deceased (n=80)	Total (n=234)
Outcome status	154 (65.8%)	80 (34.2%)	234 (100%)
Type of death (among deceased)			
On-the-spot deaths		32 (40.0%)	
Delayed deaths after admission		48 (60.0%)	
Sex			
Male	102 (66.2%)	54 (68.0%)	156 (66.7%)
Female	52 (33.8%)	26 (32.0%)	78 (33.3%)
Age group (years)			
<20	22 (14.3%)	8 (10.0%)	30 (12.8%)
21–40	58 (37.7%)	26 (32.5%)	84 (35.9%)
41–60	46 (29.9%)	28 (35.0%)	74 (31.6%)
>60	28 (18.1%)	18 (22.5%)	46 (19.7%)

Primary impact injuries were observed in 60 (75%) of deceased pedestrians compared to 70 (45.5%) of survivors. Ground impact injuries were present in 55 (68.8%) of deceased victims, while only 30 (19.5%) of survivors sustained such injuries. Both injury types were more prevalent among deceased pedestrians; however, ground impact injuries demonstrated

a particularly strong association with fatal outcomes. Since injury patterns were not mutually exclusive, some victims sustained both primary and ground impact injuries. This association between ground impact injuries and mortality was statistically significant (χ^2 test, $p < 0.001$) (Table 2).

Table 2: Distribution of injury patterns among deceased and surviving pedestrians

Injury pattern	Survived (n=154)	Deceased (n=80)	Total (n=234)
Primary impact injury	70 (45.5%)	60 (75.0%)	130 (55.6%)
Ground impact injury	30 (19.5%)	55 (68.8%)	85 (36.3%)

Motorcycles were the most frequently involved vehicles in pedestrian collisions in both survivors (55.8%) and deceased victims (57.5%) (Table 3). Ground impact injuries were more frequent among on-the-spot deaths compared to delayed deaths (81.3% vs 60.4%), whereas primary impact injuries were commonly observed in delayed deaths following hospital admission (Table 4).

Table 4: Distribution of injury patterns according to type of death among deceased pedestrians (n=80)

Injury pattern	On-the-spot death (n=32)	Delayed death (n=48)
Ground impact injury	26 (81.3%)	29 (60.4%)
Primary impact injury	18 (56.3%)	42 (87.5%)

The injury spectrum ranged from superficial to severe trauma. Common injuries included skull, rib, pelvic, and long bone fractures; internal abdominal injuries; and soft-tissue injuries such as lacerations and abrasions. Head injuries predominated among deceased pedestrians, observed in approximately **62 (77.5%)**, while injuries involving both upper and lower limbs were more frequent among survivors. Skull fractures and intracranial haemorrhages were strongly associated with fatal outcomes.

Multiple injuries involving more than one body region were frequently observed among fatal cases.

DISCUSSION

This study demonstrates clear differences in injury patterns between surviving and deceased pedestrian road traffic accident victims. Fatal outcomes were predominantly associated with ground impact injuries and severe head trauma, while survivors more commonly sustained extremity and soft-tissue injuries. Similar observations have been reported in the previous forensic and trauma-based studies, where secondary injuries with the ground were identified as a major contributor to fatal injuries^{4,7}. The strong association between ground impact injuries and mortality, particularly among on-the-spot deaths, highlights the critical role of secondary injuries in determining injury severity and survival.

The predominance of head injuries, including skull fractures and intracranial haemorrhages, among deceased pedestrians underscores traumatic brain injury as a key mechanism of death. This finding is consistent with earlier studies reporting a high burden of severe head injuries among fatal pedestrian road traffic accidents^{3,4}. In contrast, delayed deaths following hospital admission were more frequently associated with primary impact injuries, suggesting progression of injury severity or post-operative complications, especially in cases requiring surgical intervention for head injuries³.

Male predominance among both survivors and fatalities is consistent with patterns reported in pedestrian trauma literature and global road safety data^{1,7,8}. This trend may reflect increased exposure to road environments and behavioural risk factors. Age-related differences were also observed, with fatalities more common in older age groups, which has been attributed in previous studies to reduced physiological reserve and higher vulnerability to severe trauma^{1,9}.

From a medico-legal perspective, distinguishing primary impact injuries from ground impact

injuries is crucial for accurate reconstruction of accident mechanisms and assessment of liability. The findings emphasize the importance of careful injury documentation and mechanism-based interpretation in forensic evaluations.

CONCLUSION

Pedestrian road traffic injuries result in substantial mortality, with fatal outcomes strongly associated with ground impact injuries and severe head trauma. On-the-spot deaths were more commonly linked to ground impact, while delayed deaths were frequently associated with primary impact injuries and surgical management of head injuries. Survivors predominantly sustained non-fatal extremity and soft-tissue injuries. These findings highlight the importance of mechanism-based injury analysis in medico-legal investigations and underscore the need for targeted preventive measures to reduce pedestrian fatalities in Sri Lanka.

LIMITATIONS

This study has several limitations. Its retrospective design relied on existing medico-legal and clinical records, which may have resulted in incomplete documentation of certain variables. Injury severity scoring and systematic toxicological analysis, including alcohol estimation, were not uniformly available and could not be analysed quantitatively. Some injury pattern distributions were analysed descriptively, limiting causal inference.

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ETHICAL ISSUES

Ethical approval was obtained from the Ethics Review Committee, Faculty of Medicine, University of Ruhuna (Ref: 2024/P/020 [17.05.2024]).

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None

AUTHOR CONTRIBUTIONS

HAVKP: Conception of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **PRR:** Conception of the work; revising the work critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **IDGK:** Design of the work; drafting the work; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CASE REPORT

ASSAULT-RELATED INJURIES COMPLICATED BY IATROGENIC ANAPHYLAXIS AND TAKOTSUBO CARDIOMYOPATHY: A MEDICO-LEGAL DILEMMA

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ABSTRACT

Introduction: Anaphylaxis is a severe allergic reaction that can affect breathing and blood circulation. It requires immediate treatment with adrenaline. Stress cardiomyopathy, also known as Takotsubo syndrome, is a temporary heart condition that mimics a heart attack but occurs without blockage of coronary arteries. It can be triggered by physical or emotional stress, including high levels of catecholamines. In medicolegal practice, complications that arise during the treatment of assault injuries may raise questions about the category of hurt. Proper evaluation depends on clear documentation of events and their sequence.

Case Presentation: A 61-year-old man was admitted with superficial injuries after an assault. These injuries were assessed as non-grievous. During routine treatment with oral amoxicillin clavulanate, he developed acute anaphylaxis requiring urgent treatment with adrenaline. Further evaluation showed stress cardiomyopathy, with no evidence of coronary artery obstruction. He recovered with supportive care. Although the original injuries were not life-threatening, a serious complication occurred during treatment. The Medico-Legal Examination Form (MLEF) clearly documented the sequence of events and their temporal relationship. The initial injuries remain classified as non-grievous, and the final legal interpretation is a matter for the judiciary.

Conclusion: The original injuries were superficial and non-grievous. During treatment, the patient developed anaphylaxis followed by stress cardiomyopathy, resulting in a life-threatening situation. The MLEF clearly documented the sequence of events, establishing both a temporal relationship and a reasonable causal link between the assault, subsequent treatment, and the complications that followed. While the injuries remain classified as non-grievous, the overall medicolegal interpretation, including the extent of legal responsibility, is a matter for judicial evaluation.

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Keywords: *Anaphylaxis; medico-legal evaluation; stress cardiomyopathy*

INTRODUCTION

Anaphylaxis is a severe allergic reaction that can affect breathing and blood circulation. It requires immediate treatment with adrenaline^{1,2}. Stress cardiomyopathy, also known as Takotsubo syndrome, is a temporary heart condition that mimics a heart attack but

**Assault-related injuries complicated by iatrogenic anaphylaxis and takotsubo cardiomyopathy:
A medico-legal dilemma**

occurs without blockage of coronary arteries³. It can be triggered by physical or emotional stress, including high levels of catecholamines^{3,4}. In medicolegal practice, complications that arise during the treatment of assault injuries may raise questions about the category of hurt. Proper evaluation depends on clear documentation of events and their sequence.

CASE PRESENTATION

A 61-year-old man was admitted to a tertiary care hospital two days after an assault by three known individuals. He was conscious and hemodynamically stable on admission. Examination showed multiple abrasions and contusions over the limbs and back. There was no head injury, fractures, or internal organ damage. Investigations were normal. Based on these findings, the injuries were categorized as non-grievous under Section 311 of the Penal Code of Sri Lanka.

He was started on oral amoxicillin clavulanate. Within 30 minutes, he developed symptoms of anaphylaxis, including shortness of breath, hypotension, tachycardia, and urticaria. He was treated with intramuscular adrenaline (0.5 mg, repeated at ten-minute intervals), oxygen, intravenous fluids, antihistamines, and bronchodilators. His condition stabilized.

Subsequently, the electrocardiogram (ECG) showed ST elevation. Serum troponin I was elevated (initially 191 ng/L, with later values decreasing). Echocardiography showed apical ballooning, and coronary angiography revealed normal coronary arteries. These findings were consistent with stress cardiomyopathy (Table 1).

Table 1: Diagnostic features of stress cardiomyopathy

Parameter	Finding	Interpretation
ECG	ST elevation	Resembles ST elevation myocardial infarction (STEMI)
Troponin I	191 ng per litre (elevated/normal <10-20 ng/L)	Indicates myocardial injury
Echocardiography	Apical ballooning without obstruction	Consistent with stress cardiomyopathy
Coronary angiography	Normal coronary arteries	Non-ischaemic origin confirmed

He was managed with monitoring and beta blockers and discharged after seven days. Follow-up confirmed recovery of heart function. The Medico-Legal Examination Form (MLEF) clearly documented the initial assault and injuries, the development of anaphylaxis after treatment and the subsequent cardiac complication. The injuries were classified as non-grievous, as they did not independently endanger life. However, the MLEF remarks column clearly recorded the full chronological sequence of hospital events and established a temporal connection between the assault, treatment, and complications. At present, the category of hurt remains non-grievous based on the original injuries. The subsequent life-threatening complication is documented as part of the clinical course.

DISCUSSION

This case shows how a patient with initially non-grievous injuries can later develop a serious complication during treatment. The assault led to hospital admission and routine care, during which the patient developed anaphylaxis after receiving antibiotics. This reaction was sudden and unpredictable, and it required immediate treatment.

Following this, the patient developed stress cardiomyopathy, which is known to occur after severe physical stress or due to high levels of

catecholamines. In this case, both the anaphylactic reaction and the administered adrenaline may have contributed to the cardiac changes.

From a medicolegal point of view, the important factor is the clear sequence of events. The injuries were correctly identified as non-grievous at the time of examination. However, the MLEF clearly documents the later complications and shows how they are temporally related to the initial assault and subsequent treatment. Therefore, while the classification of hurt remains based on the original injuries, the full clinical course must be considered. The final interpretation of these findings is a matter for the judiciary.

CONCLUSION

The original injuries were superficial and non-grievous. During treatment, the patient developed anaphylaxis followed by stress cardiomyopathy, resulting in a life-threatening situation. The MLEF clearly documented the sequence of events, establishing both a temporal relationship and a reasonable causal link between the assault, subsequent treatment, and the complications that followed. While the injuries remain classified as non-grievous, the overall medicolegal interpretation, including the extent of legal responsibility, is a matter for judicial evaluation.

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CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The presented case was conducted for medicolegal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individual.

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None.

AUTHOR CONTRIBUTIONS

AMH: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CASE REPORT

FATAL MULTI-ORGAN FAILURE FOLLOWING VASCULAR AND BOWEL INJURY DURING A SURGERY FOR HIP FRACTURE: A CASE REPORT

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ABSTRACT

Introduction: Deaths following major orthopaedic procedures in patients with significant comorbidities often raise medicolegal concerns regarding whether post-operative complications represent unavoidable surgical risk or negligence.

Case Presentation: This report describes a 56-year-old woman with long-standing multiple medical conditions, such as diabetes mellitus, hypertension, dyslipidaemia, and obesity, who sustained an acetabular fracture and underwent open reduction and internal fixation. During surgery, she developed an inadvertent external iliac artery injury resulting in torrential bleeding, which was dealt with by repairing it with a prosthetic graft. A concurrent ileal tear was repaired by end-to-end anastomosis. Despite appropriate operative management and intensive post-operative care, she developed progressive renal, hepatic, and respiratory failure and succumbed 10 days later. Forensic autopsy revealed intact vascular graft and bowel anastomosis, absence of rebleeding or leakage, and generalized pallor of most internal organs with loss of cortico-medullary differentiation of both kidneys, consistent with multi-organ failure secondary to prolonged hypoperfusion.

Conclusion: This case highlights the essential role of a forensic autopsy in differentiating recognized complications from negligence. Correlation of operative records with autopsy findings ensures accurate medicolegal interpretation and fairness to both clinicians and families.

Keywords: Autopsy; multi-organ failure; negligence; surgical complications

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INTRODUCTION

Post-operative deaths following major surgical procedures frequently attract medicolegal scrutiny. In cases involving significant intraoperative complications, the role of the forensic pathologist is to be able to determine whether the fatal outcome resulted from a recognized surgical risk or from negligence¹. Medical negligence is legally defined as a breach of the duty of care in which a practitioner fails to apply the standard of reasonable skill and prudence expected of a reasonably competent practitioner in similar circumstances (either by an act of commission/

doing something improperly or an act of omission/failing to do what should have been done), resulting in harm to the patient. For negligence to be established, there must be a duty of care, a breach of that duty, harm/damage and a clear causal link between injury and harm/damage. The vascular injury in this case, although immediately recognized and promptly acted upon, resulted in a massive haemorrhage (haemorrhagic shock), which has led to systemic hypoperfusion, metabolic acidosis, and multi-organ dysfunction²⁻⁴. Once negligence is recognized or established, the next step is to categorize it under civil or criminal negligence.

CASE PRESENTATION

A 56-year-old female with multiple comorbidities sustained a right acetabular fracture following a domestic fall and was admitted to the National Hospital of Sri Lanka, a tertiary care institution. Open reduction and internal fixation (ORIF) was performed on an urgent basis due to fracture instability and risk of complications related to prolonged immobilisation.

During surgery, an iatrogenic injury to the right external iliac artery occurred, resulting in significant haemorrhage. Immediate vascular repair was performed using a prosthetic graft (Figure 1), and haemostasis was achieved. A concomitant ileal injury was identified and managed with a primary end-to-end anastomosis (Figure 2). All intraoperative events, including vascular repair, bowel repair, and transfusion requirements, were contemporaneously documented in the bed head ticket.

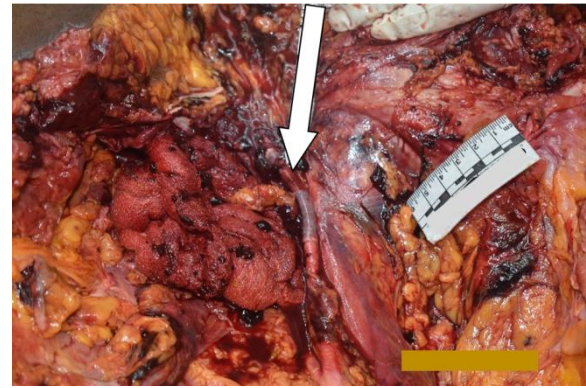


Figure 1: Prosthetic vascular graft in situ (white arrow).

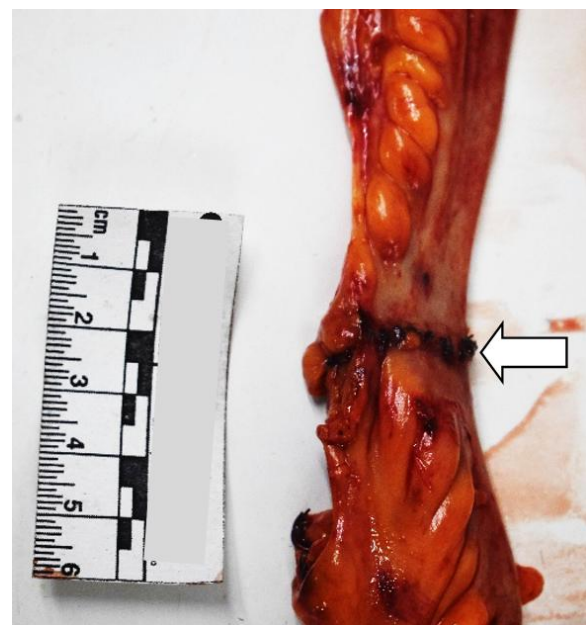


Figure 2: Surgical repair of the ileal tear (white arrow).

Postoperatively, the patient developed haemodynamic instability with coagulopathy requiring massive transfusion support and vasopressor therapy. Two re-explorations were performed. The first demonstrated no active haemorrhage. The second identified pelvic oozing was managed by internal iliac artery ligation and pelvic packing. Despite intensive care management, she developed progressive renal, hepatic, and respiratory dysfunction and succumbed on the tenth postoperative day.

The autopsy revealed a markedly pale body with icteric sclerae. The prosthetic graft in the right external iliac artery was intact, and the

ileal anastomosis was intact with no evidence of leakage or peritonitis. There was no evidence of rebleeding or sepsis. Multiple internal organs showed features consistent with systemic hypoperfusion, including generalized pallor, heavy oedematous lungs, mild pleural effusions, and ascites consistent with multi-organ dysfunction syndrome secondary to shock physiology following massive haemorrhage^{2,4}.

Both kidneys were of normal size without cortical shrinkage or scarring. There was an apparent loss of cortico-medullary differentiation, which was interpreted as an acute hypoperfusion-related change in the setting of global pallor of the renal cortex. Chronic kidney disease was excluded based on preserved renal dimensions and absence of chronic structural changes. The altered cortico-medullary distinction was considered secondary to acute circulatory failure rather than pre-existing renal pathology².

The cause of death was explained to the next of kin as irreversible multi-organ dysfunction syndrome secondary to prolonged systemic hypoperfusion following massive intraoperative haemorrhage due to iatrogenic injury to the external iliac artery during open reduction and internal fixation of an acetabular fracture. The vascular and bowel injuries were recognised as operative complications that were promptly identified and managed in accordance with accepted surgical principles. There was no autopsy evidence of ongoing bleeding, anastomotic failure, or septic complication.

DISCUSSION

Post-operative death following major orthopaedic trauma surgery often results from a convergence of haemorrhagic shock, systemic inflammatory response, and progressive organ dysfunction rather than a single isolated event¹. The transition from compensated shock to irreversible multi-organ failure is influenced by the duration and severity of tissue hypoperfusion, even when surgical control of bleeding is achieved². Age-related comorbidities, including diabetes mellitus, hypertension, dyslipidaemia, and obesity, are

recognised modifiers of perioperative outcome and may reduce physiological reserve in the context of major surgical stress⁵.

In this case, the initial massive haemorrhage created a critical period of global oxygen debt, which likely triggered downstream endothelial injury, microcirculatory collapse, and mitochondrial dysfunction, key mechanisms implicated in multi-organ failure after major trauma and surgery²⁻⁴. Such systemic derangements may continue despite anatomical correction of the primary injury.

Age, comorbidities, and physiological reserve are important modifiers of outcome in hip fracture surgery, with evidence showing higher perioperative morbidity and mortality in patients with metabolic and cardiovascular risk factors⁵. These factors likely contributed to reduced resilience against the physiological stress imposed by major haemorrhage and repeated surgical interventions in this patient.

From a medicolegal perspective, postoperative mortality must be interpreted in the context of accepted surgical risk and patient vulnerability. Objective correlation of intraoperative events, perioperative course, and autopsy findings is essential to distinguish unavoidable complications from negligent practice, ensuring balanced and evidence-based forensic conclusions¹.

CONCLUSION

This case demonstrates the importance of distinguishing unavoidable surgical complications from negligent practice. External iliac artery injury is a rare but recognized complication of acetabular fracture surgery. In this case, the complication was immediately identified, corrected using standard techniques, and thoroughly documented. Postoperative care followed accepted protocols, and no grossly negligent acts were evident.

Accordingly, the findings are consistent with a recognised but uncommon complication of a high-risk orthopaedic procedure with no pathological evidence of breach of duty of care or operative negligence when assessed in correlation with intraoperative documentation, perioperative course, and autopsy findings¹.

Forensic pathology does play a critical role in objectively assessing postoperative deaths by correlating operative details with autopsy findings. This ensures that conclusions remain scientifically grounded, legally sound, and fair to both grieving family members and clinicians.

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CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The case was conducted for medicolegal purposes, and the findings were used for academic purposes in accordance with institutional guidelines, without divulging the individual's identity.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

AMH: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CASE REPORT

CHALLENGES IN THE MULTI-DISCIPLINARY MANAGEMENT OF INTIMATE PARTNER VIOLENCE CASES IN SRI LANKA: A CASE REPORT

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ABSTRACT

Introduction: Intimate partner violence (IPV) is a major public health issue associated with significant physical and psychological morbidity. In Sri Lanka, social stigma and delayed legal intervention may further worsen mental health outcomes among victims.

Case Presentation: A 42-year-old mother of three presented to the National Hospital of Sri Lanka with severe depression, dissociative symptoms, and suicidal ideation following approximately two decades of IPV. Her husband reportedly exhibited morbid jealousy, alcohol dependence, and polysubstance abuse. Past medical history included assault-related head injury, post-traumatic seizures, and a previous suicide attempt by drug overdose. Following psychiatric evaluation and family intervention, the patient was referred for medicolegal examination and legal protection under the Prevention of Domestic Violence Act, No. 34 of 2005. Limited physical examination revealed no fresh injuries, while full examination was declined by the patient. Despite multidisciplinary management involving psychiatric, medicolegal, and social support services, the patient remained vulnerable due to persistent psychological distress, financial dependency, and limited social support.

Conclusion: This case highlights the cumulative psychiatric impact of chronic IPV and emphasizes the importance of coordinated medicolegal intervention, sustained psychiatric care, and strengthened social support systems for vulnerable victims.

Keywords: Depression; intimate partner violence; medicolegal

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INTRODUCTION

Intimate partner violence (IPV) affects an estimated one in three women worldwide, according to the World Health Organization (WHO)¹. Local statistics from the women and child protection bureau show a declining trend in violence from 2022 to 2024, and the same period also shows an increase in the number of protection orders issued. Such abuse frequently results in long-term psychiatric complications, including depression, anxiety, post-traumatic stress disorder (PTSD), and dissociation².

The Prevention of Domestic Violence Act No. 34 of 2005³ is a great tool that provides a mechanism for protection orders and

emergency intervention; however, enforcement remains inconsistent³. This may be due to a lack of knowledge and awareness among the public. Social media and local media can play a vital role by educating and creating awareness among the public. Victims often delay reporting due to fear, social stigma, and economic dependency. This situation follows the pattern of Stockholm Syndrome, which is a recognized psychological phenomenon in which a person who is being abused, threatened, or held under the control of another develops emotional attachment, sympathy, or loyalty towards the perpetrator.

CASE PRESENTATION

A 42-year-old married woman, mother of three, was admitted to the psychiatric unit of the National Hospital Sri Lanka on January 25, 2025, following a dissociative episode and suicidal ideation. During my medicolegal examination, it was very difficult to get a history from her as she was clinically depressed and did not even make eye contact. The bed head ticket (BHT) records were useful to understand her background story. During the second session, she was talking more freely, and her daughter was also present. According to her, she was the only victim in the family; her husband had never assaulted the children (the eldest daughter had finished her education, while the other two were still schooling). She has endured 20 years of recurrent IPV, including physical assaults and emotional breakdowns, from her husband, who displayed morbid jealousy, alcohol dependence, and poly-substance abuse. These are strong predisposing factors for the ongoing physical abuse, along with financial burden and lack of education. The psychiatric team had a family intervention with the husband and the eldest daughter. During this intervention, the husband acknowledged most of the allegations and agreed to undergo rehabilitation and treatment.

Her medical history included multiple admissions; a head injury 15 years ago due to assault, with subsequent post-traumatic

seizures, and a suicide attempt by amitriptyline and metformin overdose (Table 1 and Figure 1).

Table 1: Summary of hospital admissions and outcomes

Year	Presentation	Cause	Outcome
2010	Head injury	Physical assault	Healed
2022	Seizures	Post-traumatic	Controlled with medication
2024	Drug overdose (amitriptyline and metformin)	Suicide attempt	Recovered
2025	Dissociative episode	Chronic IPV	Psychiatric admission

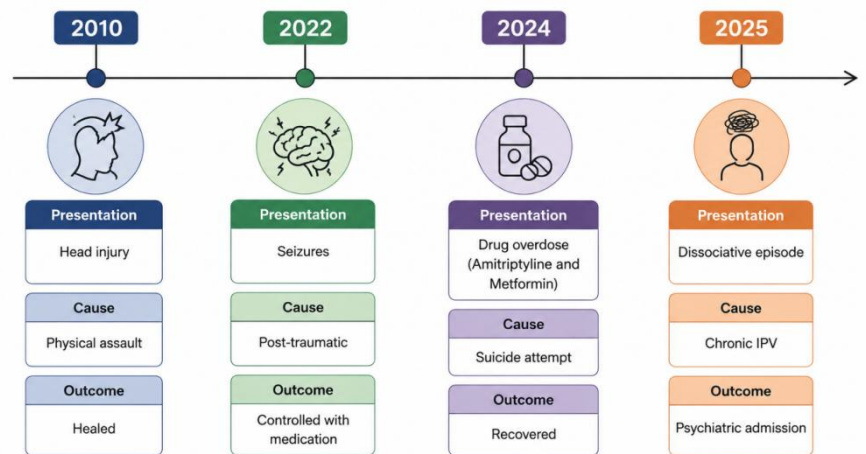


Figure 1: Timeline of hospital admissions and outcomes.

Her only consistent emotional support was her adult daughter, who was planning to marry and leave home soon, leaving the patient at risk of isolation.

Following the psychiatric admission and the family intervention, the patient was referred for medicolegal examination. A limited physical examination (where only the exposed portions of her body, including face, neck, upper limbs, and feet) was done with her consent. There were no fresh injuries, and there was no recent history of assault. The need of the hour was for a full physical examination to rule out/confirm scars and other evidence of chronic physical abuse, but she did not give consent for this (her

refusal was documented in the MLEF). Referrals were made to “Women In Need”, “Children and Women Bureau”, and “Mithuru Piyasa” for social and legal support. A protection order was sought under the Prevention of Domestic Violence Act No. 34 of 2005³. The medicolegal team collaborated closely with psychiatric and social services to ensure continued follow-up.

Pharmacotherapy with Selective Serotonin Reuptake Inhibitors (SSRIs) and short-term anxiolytics was initiated. Cognitive Behavioural Therapy (CBT) was also started simultaneously for empowerment, safety planning, and relapse prevention. The patient and her daughter were informed of emergency contacts, including the 1938 national women helpline⁵.

However, adherence to treatment was poor. The patient expressed fear of societal stigma and financial dependency on her husband. Despite protection orders, enforcement remained inadequate, and the lack of sustainable shelter options prevented her from living independently.

DISCUSSION

Intimate partner violence (IPV) is increasingly recognized not only as a social and legal issue but also as a major determinant of long-term physical and psychiatric morbidity. Global data indicate that IPV remains highly prevalent despite legal and public health interventions, with substantial regional variation and persistent underreporting, particularly in South Asia⁴. Victims of chronic IPV frequently develop depression, anxiety, dissociative symptoms, post-traumatic stress disorder, and suicidal behaviour, especially when exposure to abuse is prolonged and recurrent. The present case demonstrates the cumulative psychiatric impact of long-standing IPV complicated by social isolation, financial dependency, and inadequate psychosocial support.

A critical concern in IPV-related morbidity is the potential escalation from chronic abuse to severe injury or fatal violence. Domestic homicide reviews have shown that intimate partner homicides are often preceded by repeated assaults, coercive control, and multiple prior contacts with healthcare or legal

services⁵. Early recognition of high-risk indicators within psychiatric, emergency, and forensic settings is therefore essential, even when physical findings are minimal or absent at the time of examination. In this case, although no fresh injuries were identified during the limited physical examination, the absence of demonstrable injuries did not exclude prior or ongoing abuse. Delayed presentation, repetitive low-force assaults, and healing of previous injuries may reduce objective physical findings despite a significant history of violence. From a psychosocial perspective, prolonged exposure to abuse may result in trauma bonding and maladaptive attachment patterns that impair a victim’s ability to disengage from the abusive environment⁶. Such psychological dependence may contribute to delayed reporting, reluctance to pursue legal remedies, poor adherence to treatment, and recurrent psychiatric crises. These features were evident in the present case, where the patient remained emotionally vulnerable despite multidisciplinary intervention and continued to depend financially and socially on the perpetrator.

Management of IPV-related psychiatric crises in many high-income countries involves coordinated multidisciplinary systems integrating law enforcement, mental health services, social support agencies, legal advocates, emergency shelters, and structured risk assessment pathways. Such approaches facilitate rapid implementation and enforcement of protection measures with continued follow-up. Although India shares several sociocultural barriers similar to Sri Lanka, initiatives such as one-stop crisis centres and fast-track legal mechanisms have improved coordination of medicolegal and psychosocial care despite ongoing resource limitations. In contrast, Sri Lanka continues to face challenges, including inconsistent enforcement of protection orders, limited shelter availability, and fragmented interagency collaboration, all of which may hinder long-term safety and recovery in IPV victims.

Overall, current literature suggests that effective IPV management requires more than episodic medical or legal intervention. Sustained recovery depends on continuous risk

reassessment, integration of psychiatric and medicolegal services, effective legal protection mechanisms, and long-term social support systems for vulnerable victims⁴⁻⁶.

CONCLUSION

Chronic IPV may present primarily with psychiatric morbidity (depression, anxiety, suicidal ideation) even in the absence of fresh injuries or visible scars at examination. Lack of recent physical findings does not exclude ongoing abuse, particularly in repetitive, low-force, or temporally spaced violence. Scar dating is of limited medicolegal utility beyond approximately 6–8 weeks, as progressive maturation leads to loss of objective features required for reliable age estimation; thus, older scars cannot be accurately timed, although they may still corroborate prior trauma when interpreted alongside history and psychiatric assessment.

This case underscores the persistent vulnerability of IPV survivors in Sri Lanka despite multidisciplinary intervention, largely due to gaps in enforcement and limited social support. Strengthening protection order implementation, expanding shelter services, and integrating IPV screening into routine healthcare are essential for improving long-term safety and outcomes.

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ETHICAL ISSUES

The presented case was conducted for medicolegal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individual.

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AUTHOR CONTRIBUTIONS

AMH: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CASE REPORT

INTERPRETING CHARACTERISTICS OF OFFENDERS BASED ON INJURY PATTERNS OF HOMICIDE VICTIMS: TWO CASE REPORTS

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ABSTRACT

Interpreting offender characteristics based on injury patterns in homicide victims is a complex yet valuable concept in forensic investigations. There are several studies in the literature that explore the association between injury pattern and offender characteristics, but findings remain inconsistent and difficult to generalise. This article discusses two cases of homicide, based on the relevant literature available. Overkilling or mutilation was frequently considered a special injury pattern in literature and described as a marker of intense emotional arousal or personal conflict between the victim and the offender. Both homicides demonstrated this pattern. However, interpreting offender characteristics based on the victim's injury pattern should be done critically within a broader psycho-socio-behavioural context.

Keywords: *Homicide; mutilation; overkilling; psychological autopsy*

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INTRODUCTION

Injury pattern interpretation is one of the most important aspects of forensic investigations. It is widely used in event reconstruction, commenting on circumstances, and determining the cause and manner of death¹. These applications are primarily victim-focused,

and the underlying principles and theories are well established. In contrast, interpreting offender characteristics based on injury patterns observed on the victim remains a complex and challenging concept and is not widely applied². However, its potential value is considerable when supported by reasonable theories and principles³.

Although several studies in the literature have explored the association between injury patterns of homicide victims and offender traits, inconsistencies and small sample sizes limit the generalisability of these findings. In the past, the interpretation of homicide injury patterns has been used to obtain potential clues about serial killers, based on the belief that they employ specific or repetitive patterns during their crimes⁴. But if there are studies that can be applied to interpret offender characteristics based on injury patterns inflicted on homicide victims, it will be an important aspect in medico-legal investigations into homicides. Through this article, we discuss two homicide cases in which the dead person had a characteristic injury pattern and critically

analyse them with findings of relevant literature.

CASE PRESENTATION

Case 01:

A 28-year-old male was allegedly assaulted and killed in front of his father by five previously known individuals in relation to a dispute associated with illicit drug trading. Sharp weapons, swords, and manna knives were reportedly used.

External examination revealed fifteen sharp-force injuries comprising slash and chop cuts over the head, trunk, and limbs, with marked predominance in both lower extremities. The lower parts of both legs showed multiple deep cuts with near-total dismemberment, including a cut through the tarsal bones of the left heel (Figure 1), indicating application of considerable force.



Figure 1: Photograph showing multiple slash and chop cuts involving muscles and bones in both lower limbs, causing near-total dismemberment (circled).

Furthermore, a cut injury of the scalp with an underlying cut fracture of the skull (Figure 2), chop injury to the posterior right chest with cut of muscles and vessels, entering the thoracic cavity and causing a right haemothorax and a severe chop injury of the left lower back, opening into the peritoneal cavity with protrusion of small bowel loops, and partial transection of the left kidney were observed during the autopsy. Internal organs were severely pale. Death was attributed to haemorrhagic shock following multiple sharp-force injuries to the head, trunk, and limbs. The manner of death was determined as homicide.



Figure 2: Photograph showing multiple deep slash and chop cuts over the scalp associated with cut fractures of the cranial vault.

Case 02:

A 34-year-old male was allegedly assaulted at his residence by four individuals in front of his wife and two young children, reportedly in retaliation for a previous offence. Sharp weapons, including swords, were used. Scene examination revealed the body lying in a large pool of blood, indicating substantial haemorrhage at the scene of assault.

External examination demonstrated ten deep, sharp-force injuries comprising slash and chop over the head, trunk, and limbs, with a predominance over the back. A severe chop injury of the scalp produced a cut fracture of

the skull with transection of the cerebellum. A deep cut to the neck extended up to the cervical vertebrae, causing a complete transverse cut of the vertebral body. Injuries to the upper limbs showed marked mutilation, including partial traumatic amputation of the right upper limb at the shoulder joint (Figure 3) and disarticulation of the left hand at the distal forearm, in which vital reactions were minimal. (Figure 4). Internal organs were markedly pale. Death was due to haemorrhagic shock following multiple sharp-force injuries to the head, trunk, and limbs. The manner of death was stated as homicide.



Figure 3: Photograph showing multiple slash cuts over the back of the chest with a chop cut in the right shoulder area, causing partial traumatic amputation of the right upper limb at the shoulder joint. (circled)



Figure 4: Photograph showing disarticulation/amputation of the left hand at the distal forearm (circled). Two parts were closely placed for reconstruction.

DISCUSSION

Interpretation of offender characteristics from injury patterns in homicide victims remains difficult because homicide-related violence is influenced by multiple interconnected biological, psychological, social, and situational factors. Here we discussed several studies which attempted to explore associations between injury pattern and offender behaviour, psychological state, and victim–offender relationships.

Overkilling and mutilation are among the most frequently discussed injury patterns when interpreting the behaviour of the offenders. Kopacz et al. described overkilling as the infliction of excessive injuries beyond those required to cause death, often characterised by repetitive or severe violence directed toward the victim⁵. Such injuries are commonly associated with intense emotional arousal, uncontrolled aggression, interpersonal conflict, or expressive violence rather than purely instrumental killing⁶. Tavone et al., in their analysis of 71 overkill homicide cases, similarly

demonstrated associations between excessive violence, close victim–offender relationships, and emotionally driven motives². In both cases presented here in the article, the multiplicity, severity, and destructive nature of the sharp-force injuries were consistent with patterns of overkilling described in previous literature.

Mutilation has also been widely discussed in forensic and criminological literature because of its perceived association with psychopathology of the offender and the aim of concealment of identity of the victim or symbolic aggression⁷. Guggenheimer et al., in a nationwide Swedish study on criminal mutilation, identified rage and concealment as the most frequent motives associated with body mutilation⁸. Häkkänen-Nyholm et al. similarly reported that postmortem mutilation was commonly associated with offenders known to the victims and that concealment of identity was a major motive⁹. In contrast, neither of the presented cases demonstrated attempts at facial destruction or concealment of identity despite the presence of severe limb mutilation and near-dismemberment injuries. This suggests that the mutilation observed in these cases was more likely related to excessive retaliatory violence, domination, or symbolic aggression rather than concealment.

Another notable feature in both cases was the presence of previously established relationships between victims and offenders. Several studies have demonstrated that excessive violence is more commonly observed in homicides involving interpersonal connections. Emotional conflict, revenge, humiliation, and prior disputes may contribute to the escalation of violence beyond what is necessary to cause death. Tavone et al. observed that offenders involved in overkill frequently had emotional or personal relationships with victims, while other homicide studies have similarly demonstrated increased injury severity in impulsive homicide compared to instrumental homicide. In the first case here, the homicide reportedly occurred in relation to an illicit drug-related dispute, whereas the second case involved retaliation for a previous offence. The targeted and repetitive nature of the injuries in both cases may therefore reflect emotionally charged violence directed toward specific individuals.

The places where both assaults had taken place are also forensically important. In the first case, the assault occurred in front of the victim's father, while in the second case, the attack was witnessed by the victim's wife and children. Public or family-witnessed violence may function as a form of intimidation, humiliation, punishment, or symbolic domination^{6,10}. Excessive injury production in such circumstances may therefore extend beyond the immediate goal of killing and serve communicative or retaliatory purposes.

The predominance of male offenders in both cases is also consistent with existing homicide literature. Studies on violent crime and sharp-force homicide have repeatedly demonstrated that males constitute the majority of offenders involved in aggressive interpersonal violence and retaliatory killings^{2,6,8,11,12}. Biological, behavioural, and sociocultural factors have all been proposed to contribute to this predominance. Furthermore, previous studies on overkill and mutilation have similarly reported male predominance among offenders. Although gender alone cannot predict behavioural patterns, the findings in the presented cases are consistent with observations and findings of existing literature/studies on violent homicides.

An important distinguishing feature of the presented cases from available literature is the involvement of multiple offenders. Most published studies discussing overkilling or mutilation focus predominantly on single offenders, frequently in the background of psychiatric illness, intimate partner homicide, sexual homicide, or serial violent crime. In contrast, both homicides described in this article involved organized group assaults. Collective violence may significantly alter injury patterns because multiple offenders can simultaneously inflict repetitive and severe injuries, resulting in extensive tissue destruction that may resemble pathological mutilation traditionally associated with single offenders. Therefore, the interpretation of mutilation or overkilling solely as evidence of offender psychopathology may be misleading when there are multiple offenders.

These presented cases, therefore, highlight the limitations of interpreting offender characteristics exclusively from injury morphology. Although injury patterns may provide useful behavioural clues, they should always be interpreted together with scene findings, victimology, offender–victim relationships, motivation, sociocultural background, witness accounts, and investigative information^{3,13,14}. Petherick, in his article, emphasized that modern offender profiling should adopt an integrated multidisciplinary approach rather than relying on stereotype-based assumptions or isolated behavioural indicators¹³. The findings of the presented cases support this view and demonstrate the importance of contextual interpretation in forensic behavioural analysis.

CONCLUSION

These findings of two cases emphasize that the interpretation of offender characteristics from injury patterns should not be performed in isolation. Meaningful forensic interpretation requires integration of injury morphology with contextual factors, including offender–victim relationships, motive, collective violence, scene findings, and behavioural evidence of offenders. Careful multidisciplinary analysis may improve understanding of complex homicide patterns while reducing the risk of misinterpretation of offender profiling.

Therefore, injury patterns should be analysed critically within a broader socio-behavioural framework. Systematic documentation of injuries, integration of offender-related information, and interdisciplinary collaboration are essential for advancing this field. Such approaches may facilitate more comprehensive and methodologically valid future studies.

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CASE REPORT

PAEDIATRIC INFECTIVE ENDOCARDITIS PRESENTING AS INTRACRANIAL HAEMORRHAGE: A MEDICO-LEGAL DIAGNOSTIC CHALLENGE

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ABSTRACT

Introduction: Intracerebral haemorrhage (ICH) and subarachnoid haemorrhage (SAH) in children represent diagnostic and medicolegal dilemmas, because more often than not, there is no history of trauma. Non-accidental injury (NAI)/ suspected physical abuse is often suspected in such cases, yet natural causes must not be ruled out completely. Infective endocarditis (IE), though rare in children, can lead to septic embolization and vascular rupture resulting in ICH and SAH, often mimicking traumatic head injury.

Case Presentation: This case study represents a ten-year-old girl who was admitted to a local hospital with loss of consciousness following a brief febrile illness. She was immediately transferred to the nearest tertiary care unit (National Hospital of Sri Lanka/ NHSL), and neuroimaging revealed right frontal ICH with SAH extension. Subsequent investigations demonstrated methicillin-sensitive *Staphylococcus aureus* (MSSA) bacteraemia and echocardiographic vegetations on the mitral valve, confirming IE. The child was treated with intravenous antibiotics and supportive care, and she eventually made a full recovery.

Conclusion: This case highlights the challenges in distinguishing natural from inflicted/traumatic paediatric haemorrhages and highlights the diagnostic value of multidisciplinary collaboration among forensic, paediatric, microbiology, and cardiology teams. Paediatric IE is rare because valvular endocardial damage and sustained bacteraemia seldom occur in healthy children; however, when it does, it usually involves a highly virulent organism or pre-existing cardiac anomalies. Awareness of this presentation prevents misinterpretation of infection-related brain bleed as child abuse, ensuring accurate medicolegal assessment.

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Keywords: *Infective endocarditis; non-accidental injury; paediatric haemorrhage; Staphylococcus aureus*

INTRODUCTION

Intracerebral haemorrhage (ICH) and subarachnoid haemorrhage (SAH) in children are uncommon but, like in adults, can be life-threatening emergencies. From a medico-legal standpoint, the primary challenge lies in differentiating NAI from natural causes¹. While inflicted trauma is frequently suspected in unexplained intracranial bleeding, infection-

related vascular pathology such as infective endocarditis (IE) must also be considered².

Paediatric infective endocarditis (IE) is rare, with an estimated incidence of 1-2 per 100,000 children per year³. This condition is less common in children because the cardiac endothelium in healthy hearts is smooth and resistant to bacterial colonisation. Hence, most cases in children occur in those with congenital heart disease, prosthetic valves, indwelling catheters, or immune-compromised states⁴. In the absence of structural heart lesions, infection typically involves highly virulent organisms, especially *Staphylococcus aureus* or *Streptococcus pneumoniae*, which possess strong adhesins and invasive capacity.

Viruses seldom cause IE because they lack the adhesion molecules and enzyme systems necessary to attach to and proliferate with cardiac valves. Instead, viral infections typically cause myocarditis or pericarditis, not valvular vegetations.

IE begins with endothelial injury caused by turbulent blood flow or foreign material. This injury promotes deposition of platelet-fibrin thrombi, forming a nidus for bacterial colonization during transient bacteraemia. Bacteria adhere to these thrombi, leading to vegetation formation composed of fibrin, inflammatory debris, and microorganisms.

Adult IE presentation is typically sub-acute, often in the context of degenerative or prosthetic valves with low-grade fever, weight loss, and peripheral stigmata. In contrast, paediatric IE tends to have an acute onset, rapid progression to sepsis, and higher rates of neurological complications⁵ (as seen in this case). Peripheral signs such as Janeway lesions, Osler nodes, Roth spots, clubbing, and splinter haemorrhages are less frequently observed in children because the disease course is shorter and immune complex deposition is limited.

The modified Duke criteria remain the cornerstone of diagnosis, integrating major and minor findings⁶. A definite diagnosis requires two major, or one major and three minor, or five minor criteria.

CASE PRESENTATION

A ten-year-old girl presented with fever, vomiting, and sudden collapse. CT brain imaging revealed ICH and SAH without skull fractures or external injury. The case was referred for forensic evaluation due to suspicion of NAI.

Forensic recommendations initially included a skeletal survey and fundoscopy to exclude occult injuries. However, this was not proceeded with as further investigations pointed to IE (Table 1). However, since a medico-legal examination form (MLEF) was issued for this case, medicolegal work was conducted on the sidelines- both the parents were interviewed, and there were no inconsistencies in their history. Police input was sorted, and there were no prior reports of violence (this ten-year-old girl is the elder one among two girl children).

Table 1: Key investigations and results

Investigation	Result	Interpretation
Transthoracic echocardiography	Vegetations on the mitral valve	Consistent with IE
Blood culture	Staphylococcus aureus	Source of infection
CT Angiography (of head)	No aneurysm/arteriovenous malformation	Aneurysm/arteriovenous malformation was excluded as the source of bleeding.

This child was treated with intravenous antibiotics, and she underwent close monitoring at the intensive care unit with coordinated management of paediatrics, neurosurgery, microbiology, cardiology, and forensic medicine. The final medicolegal conclusion was revised to natural disease- IE with septic emboli leading to ICH and SAH.

DISCUSSION

Spontaneous intracranial haemorrhage in children requires a broad differential diagnosis, including vascular malformations, coagulation abnormalities, neoplasms, infection, and trauma-related causes. In medicolegal practice, the absence of external injury may initially raise concern for non-accidental injury, making systematic evaluation essential for accurate classification^{1,2}.

Neurological complications are well recognised in infective endocarditis, occurring in a substantial proportion of cases, with ischaemic events being more frequent than haemorrhagic ones³. Haemorrhagic complications typically arise from septic arteritis with focal vessel wall damage and may be associated with rupture of infectious aneurysmal dilatations^{3,5}.

Paediatric infective endocarditis has distinct clinical behaviour compared to adults, often presenting more acutely and with rapid systemic involvement⁴. Neurological manifestations are more prominent in children, reflecting the aggressive nature of infection and high embolic potential⁵. Diagnostic confirmation relies on the integration of clinical features with echocardiographic and microbiological evidence as outlined in the modified Duke criteria⁶. Septic emboli from mitral vegetations likely lodge in cerebral arteries, producing infectious arteritis, mycotic aneurysm formation, and eventual rupture.

From a medicolegal perspective, this case underscores the importance of avoiding premature attribution of intracranial bleeding to trauma. Correlation of imaging, blood culture results, and echocardiographic findings is critical for establishing an infective aetiology and ensuring an evidence-based conclusion.

CONCLUSION

Paediatric IE remains a rare but serious condition that may present as an intracranial haemorrhage leading to suspicion of NAI. Recognition of IE's pathophysiology, risk factors, and distinctive diagnostic features is

essential to avoid medicolegal misinterpretation. A multi-disciplinary, evidence-based approach, including early echocardiography, microbiology, and forensic input, ensures accurate identification of natural causes. Objective medicolegal documentation promotes justice and protects families from false allegations while supporting transparency and accountability.

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ETHICAL ISSUES

The presented case was conducted for medicolegal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individual.

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CASE REPORT

SUICIDE BY AN IMPROVISED FIREARM, FIRECRACKER POWDER AND A HOMEMADE, LATHE-TURNED PROJECTILE: A CASE REPORT

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ABSTRACT

Introduction: In Sri Lanka, most suicides are by hanging or poisoning, with firearm-related deaths being rare due to the regulation of the ownership through the “Firearm Ordinance”. Yet, improvised weapons may occasionally be used by individuals with technical skills who attempt to replicate firearm mechanisms. Black powder, easily obtained from firecrackers, once confined inside a metal tube, produces enough pressure to drive a projectile with surprising force. This case report describes an improvised firearm, propellant, and projectile used in a suicidal shooting and underlines the value of recognizing non-conventional gunshot injuries in forensic work.

Case Presentation: A middle-aged man was found dead in his lathe workshop, lying on the back. He had a large wound on the right side of his head and a smaller wound on the left. A set of steel tubes clamped into a vice, a loose metallic projectile nearby, and a cigarette lighter in his hand suggested that he had constructed and used a homemade gun. The workshop also contained several handmade bullets and steel sheets marked by projectile impacts, indicating repeated experimentation. At autopsy, the right-sided wound showed blackening and burning typical of a contact discharge, while the left side showed a smaller exit wound. The skull was shattered with inward beveling at the entry and outward beveling at the exit, and the brain was extensively damaged. Calculations showed that about 72 g of black powder could generate roughly 216 kJ of energy, enough to propel a small projectile at speeds comparable to modern firearms. Death was certified as cranio-cerebral injuries caused by a metallic projectile traveling through the head.

Conclusion: This case demonstrates that even firecracker powder, when confined, can act as a lethal propellant. The resulting wounds were indistinguishable from those caused by regular firearms. Forensic specialists should therefore consider the possibility of improvised weapons, especially in places where conventional firearms are scarce but pyrotechnic material is readily accessible.

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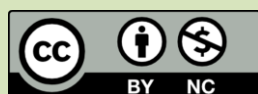
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Keywords: *Firecracker; gunshot; suicide*

INTRODUCTION

Although improvised firearms are not commonly encountered in everyday forensic practice, they tend to emerge in the hands of people who possess mechanical skill and a certain level of curiosity, or desperation. These devices often evolve from experimentation rather than criminal inventiveness. When a metal tube is sealed,

packed with pyrotechnic material, and paired with a hand-made projectile, the combination can generate ballistic forces not far from what one might see in a conventional firearm¹⁻³.

The difficulty for forensic pathologists is that the injuries produced by such improvised devices look remarkably similar to those caused by factory-manufactured firearms. Entry and exit wounds behave according to physics, not the sophistication of the weapon^{1,4}. The surrounding context, the workbench, the tools, the sketches, and the traces of experimentation often provide insight into how the fatal event unfolded.

This report describes a case in which a machinist, clearly familiar with tools and metalwork, appears to have developed a homemade discharge device using a steel tube and firecracker powder. His drawings, test strikes on a steel sheet, and half-completed bullets tell a story of gradual trial and error leading up to a single, fatal act. The case underscores the importance of integrating the autopsy findings, the physical environment, ballistic estimates, and the behavioural clues left behind.

CASE PRESENTATION

The deceased, a middle-aged machinist, was found lying on his back near the entrance of his small workshop. The door stood open, and the scene was undisturbed. On the concrete floor beside him was a set of four steel tubes, welded together to minimise relative movement. Each tube was roughly 30 cm long and held in a bench vice on the ground (Figure 1). The arrangement suggested that he had positioned the device intentionally at floor level and fired it while lying next to it.



Figure 1: Steel tubes clamped in a bench-vice (black arrow) next to the deceased.

Inside the workshop, empty firecracker casings, a fine dusting of black-coloured powder, several partly finished metal projectiles, and neatly drawn sketches (Figure 2a) showing different projectile designs were found. A steel sheet propped against the wall displayed several circular impact marks, some shallow, others punched in deeper, indicating repeated test firing (Figure 2b). A cigarette lighter remained in his right hand, which was in a cadaveric spasm (Figure 3).



Figure 2: Hand-drawn sketches of a projectile (a) and a metal sheet with circular impact marks (white arrow) (b).



Figure 3: Cigarette lighter held in the right hand (white circle).

The collected projectile was not sent for ballistic examination. Taken together, the scene painted a picture of a man who had been experimenting, possibly for days, before the final event.



Figure 4: Fully machined metallic projectile (black arrow) found at the scene.

Among the items collected from the scene was a fully machined metallic projectile, 3.0 cm long, 1.8 cm in diameter, and weighing 20 g (Figure 4). Its clean finish and symmetry matched the drawings found inside the workshop. The steel tube used as the firing chamber was open at one end and sealed at the other, with a smooth inner surface, fitting the typical configuration of a simple pipe-gun-type device.

The most striking feature on the body was a large, stellate-shaped defect on the right parieto-temporal area of the head, measuring about 8x6 cm (Figure 5a). The wound was blackened with soot deeply embedded in the margins. Hair around the site was scorched and curled. The skull fractures radiated inwards from the entry site, with comminution of the right temporal and parietal bones (Figure 5b).



Figure 5: Large, stellate-shaped defect on the right side of the head (a) and massive comminution at the right temporal and parietal bones (b).

On the opposite side, over the left temporal–occipital region, was a smaller, irregular exit wound about 1.5 cm in diameter. Bone fragments were visible, and outer bevelling was noted (Figure 6). The brain was extensively disrupted. Both cerebral hemispheres showed laceration, cavitation, and tissue displacement, with partial extrusion through the exit wound. The rest of the internal examination did not reveal any disease or trauma relevant to the death.

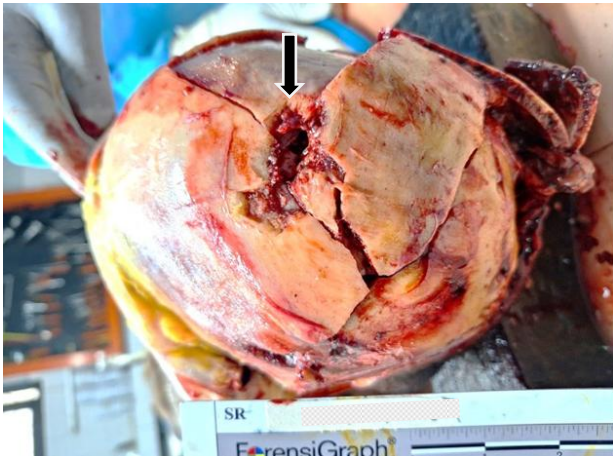


Figure 6: Irregular deficit of the skull on the left side with outward bevelling (arrow).

DISCUSSION

Improvised firearms often surprise people with the amount of energy they can produce. Even a simple mixture used in firecrackers releases significant chemical energy when ignited. Black-powder-type compositions release around 3000 J/gram^{5,6}, and when confined, the gas expansion can accelerate a projectile to remarkably high speeds.

Based on an internal diameter of 2 cm, the tube would hold approximately 94 cm³. Using standard density values for pyrotechnic black powder (≈ 1 g/cm³), a realistic fill level of around two-thirds corresponds to roughly 60–72 g of powder^{5,6}. The presence of multiple empty firecracker casings nearby strongly supported that he had sourced the propellant material from those. Considering the filled mass of 60g of powder, the total energy produced would be 180 kJ. Estimated energy transfer of black powder; 30% - 40%, without the loss due to friction⁷. If a fraction of 5% of energy is transferred as kinetic energy, it amounts to 9000 J. But for a 20 g projectile, even

such small percentages can translate into velocities exceeding 900 m/s, which exceed common handgun muzzle speeds^{6,8,9}. These velocities match well with the destructive head injury observed.

Similar cases have been reported internationally, usually involving homemade weapons produced by individuals with technical backgrounds or significant familiarity with tools⁹⁻¹¹. They often show evidence of experimentation, including test shots, sketches, and prototypes, which were clearly present here.

What distinguishes this case is the positioning of the device: clamped in a vice but intentionally placed on the floor, with the deceased lying next to it. It suggests he took deliberate measures to brace the device and align himself before firing. That behaviour, along with the absence of any defensive injuries, disturbance, or contradictory evidence, strongly supports suicide.

LIMITATIONS

Some additional examinations were not carried out in this case. A pre-autopsy X-ray was not performed. This could have helped document the exact distribution of metallic fragments before dissection. Gunshot residue swabs were not taken from the hands. Swabs were also not obtained from the soot-blackened wound margins. Laboratory testing might have provided further confirmation of discharge products. The recovered projectile was measured and examined visually, but no formal ballistic analysis was done. In addition, the wound was not examined for unburnt powder particles, and histological examination of the scalp for propellant deposition was not performed. Despite these limitations, the scene findings and injury pattern were consistent and supported the final interpretation.

CONCLUSION

This case shows how a person with mechanical skill and access to basic tools can produce a functioning and lethal firearm using nothing more than a steel tube and firecracker powder. The resulting injury was indistinguishable from that caused by a conventional gun. What allowed the true

mechanism to be understood was not the autopsy alone, but the thoughtful reconstruction of the environment he created: the drawings, the test marks, the scattered casings, and the carefully positioned device. It reinforces a central lesson in forensic pathology: when faced with an unusual firearm-type injury, the body tells part of the story, but the room tells the rest.

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ETHICAL ISSUES

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CASE REPORT

UNUSUAL BONE INJURY IN A DIRECT LIGHTNING STRIKE: REVIEW OF A WITNESSED LIGHTNING-RELATED DEATH

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ABSTRACT

Introduction: Lightning strikes are a rare but often fatal natural phenomenon. A single strike can contain an energy level of 30 million volts, 50000 amperes, accompanied by an explosive thunder effect. Mechanisms of lightning injury are categorized as electrothermal effects- including direct strike, contact potential, side flash, step voltage, and upward streamer current- or the sixth mechanism known as pressure blast wave barotrauma.

Case Report: A 38-year-old lady was struck by lightning while crossing an open paddy field, an event witnessed by her daughter. The autopsy revealed torn clothing, superficial dry burns on the body, singeing of hair, and a split on the scalp with an associated linear skull bone fracture.

Conclusion: The blunt force trauma observed in this case is explained by the sixth mechanism (pressure blast wave barotrauma). The lightning bolt channel temperature is approximately 25000 K (24727 °C). According to Charles' law, this extreme temperature causes a rapid expansion of air, resulting in a sudden increase of pressure, equivalent to a 10 kg TNT (2,4,6-Trinitrotoluene) explosion, generating a cylindrical-shaped pressure shock wave. This pressure shock wave is responsible for the torn clothing and blunt force trauma, either directly or as a result of a fall.

Keywords: *Blunt force trauma; lightning strikes; pressure blast wave barotrauma; sixth mechanism*

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INTRODUCTION

Anaphylaxis is a severe allergic reaction that can affect breathing and blood circulation. It requires immediate treatment with adrenaline^{1,2}. Stress cardiomyopathy, also known as Takotsubo syndrome, is a temporary heart condition that mimics a heart attack but occurs without blockage of coronary arteries³. It can be triggered by physical or emotional stress, including high levels of catecholamines^{3,4}. In medicolegal practice, complications that arise during the treatment of assault injuries may raise questions about the category of hurt. Proper evaluation depends on clear documentation of events and their sequence.

INTRODUCTION

Lightning current lasts a short duration (microseconds), which minimises the burning effect. However, flashover is highly likely, making internal conduction minimal. There are five mechanisms by which lightning current may impinge on a body. They are direct strike, contact potential, side slash, step voltage, and upward streamer¹.

Lightning strikes cannot be other than accidental, but sometimes they accompany with blunt force type trauma, which can complicate the diagnosis for the forensic pathologist. The prior five mechanisms are strictly electrical, and they cannot explain the blunt force trauma. The sixth mechanism, known as pressure blast wave barotrauma, is used to explain these blunt force type injuries witnessed in lightning strikes².

We present a case with blunt force type trauma in a lightning strike victim, which is explained by the sixth mechanism, pressure blast wave barotrauma.

CASE REPORT

The body of a 38-year-old female was brought in by the police for an autopsy. According to the history given by the daughter, the deceased was crossing an open paddy field with her during a thunderstorm. They were a few meters apart when the daughter witnessed a lightning strike the ground near her mother. The mother had collapsed in the paddy field and was found to have died. The autopsy revealed a moderately built female with torn clothing (Figure 1) and superficial dry burns on the chest, abdomen, and left thigh (Figure 2).



Figure 1: Torn skirt (arrow).



Figure 2: Superficial dry burns on the chest, abdomen, and left thigh (arrows).

Blood was noted in both ears, associated with ruptured tympanic membranes. There was singeing of head hair. A 4cm long linear laceration (Figure 3a) with an associated haematoma was observed on the right side of the back of the head, with an underlying 8cm long linear fracture of the right-side parietal bone (Figure 3b). No cerebral contusions, lacerations, or meningeal haemorrhages were noted during the autopsy.

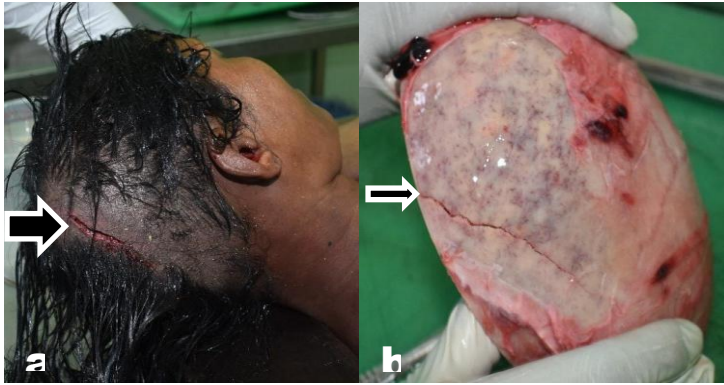


Figure 3: a) Scalp laceration (broad arrow), b) underlying linear skull bone fracture (thin arrow).

Internal examination revealed a lung contusion (Figure 4) without overlying soft tissue injury (other than burn) or rib fractures. There were no identifiable natural pathologies in the lungs, such as pulmonary infarction, coagulopathy, and all other internal organs were unremarkable. No visible exit mark was found on the body. The cause of death was concluded as a direct lightning strike. The absence of internal brain injury indicates a sudden death, specifically cardiac arrest, which prevented bleeding into the brain or meninges. The possible mechanism could be brain stem impairment and arrhythmogenic effects of the heart.

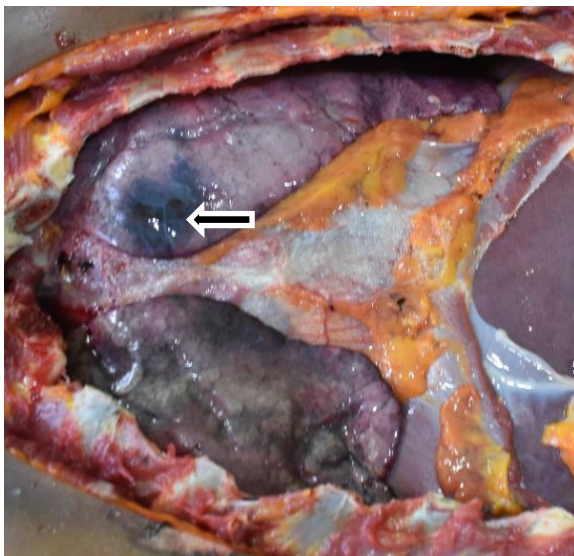


Figure 4: Contusion of the left lung (arrow).

DISCUSSION

“The temperature of the lightning bolt channel is raised to about 25000 K (24727 °C) in a few microseconds. This causes the temperature around the channel to rise suddenly, meaning that the pressure in the channel suddenly increases to several atmospheres”³. Charles's law states that for a fixed amount of gas at constant pressure, its volume is directly proportional to its absolute temperature in Kelvin.

Therefore, the large increase in temperature results in a large increase in the volume of air. This sudden rise in volume causes a sudden cylindrical-shaped pressure shock wave, which may reach pressures of more than 10-20 atmospheres (1013.25 kPa – 2026.5 kPa) in the vicinity of the lightning bolt channel⁴.

Lightning's pressure blast wave has been known to tear and tatter clothing, fracture bones, rupture a person's eardrums, and damage their lungs. The blast causes a pocket of air behind the sternum (pneumomediastinum)⁵, and it may cause injury to the chest wall and lungs⁶.

As lightning superheats, the air causing it to expand explosively, it generates a powerful pressure shock wave. The fact that thunder can be heard as far as 14 to 25 kilometres away indicates the tremendous amount of energy involved- a stark reminder of the energy contained in a lightning strike. Even before the noise is produced, this initial pressure blast wave can injure people or damage objects close to the lightning channel.

Differentiating whether the scalp laceration and skull fracture happened due to a direct result of the pressure blast wave or from a fall following the lightning strike is challenging. However, it can be hypothesised that the deceased fell as a direct consequence of the explosive force of the pressure blast wave. Torn clothing, ruptured tympanic membranes, and lung contusions are evidence of the barotrauma due to the lightning's pressure blast wave.

CONCLUSION

This case highlights the diagnostic challenge that lightning fatalities pose in forensic pathology, where coexisting blunt force injuries may obscure or mimic alternative causes of death. The pressure blast wave is capable of producing barotrauma independently of electrothermal injury. This blast wave can directly cause bone fractures or propel the victim in a fall that results in a fracture. The presence of torn clothing, tympanic membrane rupture, and pulmonary contusion without overlying chest wall injury should suggest consideration of this mechanism. Therefore, although bone injury from lightning is rare, it is essential to consider this mechanism when other signs of barotrauma are present in the absence of a clear alternative cause of injury.

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ETHICAL ISSUES

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AUTHOR CONTRIBUTIONS

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INSTRUCTIONS TO AUTHORS

The Sri Lanka Journal of Forensic Medicine, Science & Law (SLJFMSL) publishes leading articles, original research papers, reviews, points of view, case reports, technical notes and letters to the editor, in all areas of Forensic Medicine, Forensic Sciences, relevant Law & Ethics.

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The paper should be typeset with double spacing in Microsoft Word format. All pages should be numbered.

The title page should give the full title, running title, names of authors with qualifications, institutional affiliations, e-mail addresses and 16-digit ORCID number of all authors. Please underline the name of the corresponding author.

The abstract should not exceed 300 words and should illustrate what was done, the main findings and conclusions. Up to five key words should be given under the summary.

The text of research papers should be divided into Introduction, Materials and Methods, Results, and Discussion. Only generic names of drugs should be given, if applicable. Abbreviations should be spelt out when first used in the text. Scientific measurements should be given in SI units. Statistical methods should be specified in the methods section and any term which is not in common usage should be referenced.

Tables and figures should be referred to in the order of appearance in the text in Arabic numerals within parentheses, e.g. (Fig. 1). Tables should have brief titles. Figures should be used only when data cannot be expressed clearly in any other form. Photographs should have a figure number and caption and be attached as jpg files or incorporated into the MS Word document.

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Journal article

Westaby S, Evans BJ, Ormerod O. Pulmonary artery dissection in patients with Eisenmenger's syndrome. *New England Journal of Medicine*. 2007; 356:2110-2. DOI: 10.1056/NEJMc063492

Book

Saukko P, Knight B. *Knight's forensic pathology*. 4th ed. New York (NY): CRC Press; 2016. P.402.

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Ethical responsibilities

For studies involving human participants a statement detailing ethical approval and consent should be included in the methods section.

Conflicts of interest

Should be stated, if any.

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