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Research Article

A Multidisciplinary Evaluation of Sharp-Force Injuries: Clinical, Physiological, and Forensic Perspectives from a Tertiary Care Surgical Unit

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ABSTRACT

Background: Sharp-force injuries are clinically heterogeneous and may combine major anatomical damage, physiological instability, and medicolegal complexity.

Objective: To evaluate the clinical, physiological, and forensic characteristics of sharp-force injuries and identify factors associated with adverse outcomes.

Methods: This prospective multicenter observational study included 120 adults presenting with acute sharp-force injuries to Amna Inayat Medical College, Sheikhupura, and Sheikh Zayed Medical College, Rahim Yar Khan, Pakistan, from January to September 2025. Clinical variables, anatomical injury patterns, shock index, serum lactate, hemoglobin, Injury Severity Score, wound morphology, defense-type injuries, management, and in-hospital outcomes were recorded.

Results: Mean age was 32.4 ± 11.2 years; 81.7% were male. Interpersonal assault accounted for 68.3% of cases, and stab wounds for 72.5%. Major visceral or vascular injury occurred in 40.8%, while 52.5% required operative intervention, 18.3% required intensive care, and mortality was 5.0%. Adverse outcomes occurred in 37.5% of patients. Shock index >0.9, serum lactate >2 mmol/L, Injury Severity Score ≥16, and major visceral or vascular injury were independently associated with adverse outcomes. Defense-type injuries were more frequent in assault-related cases but did not independently predict clinical deterioration. Thoracoabdominal injuries carried the greatest burden of internal damage and operative management, underscoring the importance of assessment.

Conclusion: Sharp-force trauma requires integrated clinical, physiological, and forensic assessment. Early physiological compromise and anatomical severity were the strongest determinants of adverse outcome, while forensic wound patterns provided complementary medicolegal context.

Keywords: Sharp-Force Injury, Stab Wound, Penetrating Trauma, Shock Index, Serum Lactate, Forensic Medicine, Injury Severity.

INTRODUCTION

Sharp-force injuries constitute an important category of trauma encountered in emergency departments and surgical units, particularly in settings where interpersonal violence, occupational accidents, and self-inflicted injuries contribute substantially to the burden of acute care[1]. These injuries occur when the impact comes from an object having a sharp cutting edge or a sharp point and are manifested as incised wounds, stab wounds, or both. They vary widely in clinical severity from superficial soft-tissue injury to deep penetration involving major vessels, thoracic structures, abdominal viscera, or vital organs. The exact size of the wound can not be judged by external measurement alone, and a careful clinical assessment is important to determine the amount of underlying tissue involved[2,3].

Rapid assessment of life-threatening complications, including major bleeding, pneumothorax, hemothorax, cardiac injury, vascular disruption, visceral perforation, and airway compromise, is the immediate management priority for patients with sharp-force trauma[4]. Physiological responses give

good information about the severity of injury, in addition to anatomical assessment. Significant blood loss or impaired tissue oxygenation may be indicated by tachycardia, hypotension, altered shock index, decreased peripheral perfusion, increased serum lactate, metabolic disturbances, and falling hemoglobin levels. Knowing what these changes are early on can help the clinician in prioritizing resuscitation, imaging, operative exploration, transfusion, and intensive care support[5].

Sharp force injuries are also of significant medicolegal value. The number, location, orientation, depth, and morphology of wounds may be useful for the forensic interpretation of the mechanism of injury[6]. Sometimes injuries to the hands and forearms may be defensive responses, and multiple wounds may also give further context. But the individual wound characteristics need to be interpreted with caution as there can be a large amount of overlap between assault wounds, accidental wounds, and self-inflicted wounds. Conclusions should thus be drawn not only from clinical findings and wound documentation, but also from history, investigative findings and, when available, scene information[7].

A well-documented sharp force wound is critical to both the care of the patient and the medicolegal practice[8]. As long as clinical conditions allow, information about the anatomic location, size, wound margins, underlying soft tissue injury or damage, presence of active bleeding and involvement of vital organs should be documented objectively before definitive repair. Poor documentation can hinder further forensic analysis or interpretation, while too speculative a description can create bias for the legal process. This requires close liaison between surgeons, emergency doctors, anaesthetists, physiologists, radiologists and forensic experts[9].

Sharp force trauma has been explored from a surgical and forensic viewpoint, but very few clinical studies have investigated the anatomical pattern of injury, early physiological derangement, surgical requirements and the forensic characteristics in the same patient population. A multidisciplinary approach can yield a more comprehensive understanding of the severity of the injury, and better clinical and medico-legal evaluation[10,11].

The current study was then undertaken to assess the demographic characteristics, anatomical distribution of sharp force injuries, physiological abnormalities, forensic features, management of such injuries, and short-term outcomes in patients presenting with sharp force injury to a tertiary care surgical unit. The study also intended to identify clinical and physiological factors associated with adverse outcomes and to examine the relationship between wound characteristics and reported circumstances of injury[12].

MATERIALS AND METHODS

Study Design and Setting

This prospective multicenter observational study was conducted from January to September 2025 at the surgical and emergency units of Amna Inayat Medical College, Sheikhupura, Pakistan, and Sheikh Zayed Medical College, Rahim Yar Khan, Pakistan. One hundred and twenty (120) consecutive adult patients with acute sharp force injuries were included. A standardized, multidisciplinary assessment matrix that consisted of clinical injury assessment, physiological trauma response assessment, and forensic wound assessment was used for the study.

Participant Selection

Eligible patients were those aged ≥18 years who presented ≤24 hours after an injury resulting from a sharp-edged or sharp-pointed object. Stab or incised wounds that affected either the head and neck, thorax, abdomen, or extremities were included. Patients with isolated blunt trauma, firearm wounds, previously treated wounds, delay of presentation greater than 24 hours, and/or incomplete clinical or medicolegal documentation were excluded.

Clinical Evaluation

The clinical component evaluated anatomical severity and surgical implications of injury. The number of wounds, wounds involved anatomical site, predominant wound type, level of tissue damage, active bleeding, vascular damage, visceral damage, neurological damage, and associated thoracic or abdominal damage were documented for each patient. The Abbreviated Injury Scale was used to classify the severity of injury, and the Injury Severity Score was used when multiple anatomical regions were injured. Clinical outcomes included the need for emergency operating room, vascular repair, visceral repair, blood transfusion, intensive care unit admission, length of hospital stay, and in-hospital deaths.

Physiological Evaluation

The physiological component included a test of the systemic response to blood loss and tissue injury. At presentation, HR, SBP, DBP, RR, SpO2, Glasgow Coma Scale (GCS), hemoglobin (Hb), hematocrit (Hct), and serum lactate were measured. Shock index (heart rate/systolic blood pressure) was used as a measure of severe circulatory compromise; a score >0.9 was used. Hemodynamic instability was determined as blood pressure <90 mmHg or ongoing clinical signs of inadequate tissue perfusion. Next, the association of shock index, lactate concentration, hemoglobin, and hemodynamic status with the need for an operative intervention, intensive care, and death was evaluated.

Forensic Evaluation

In the forensic aspect, objective wound features and their medicolegal significance were emphasized. The wound type, number, anatomical site, surface size, surface direction, wound edges, apparent depth, and wound distribution were documented for each injury. The likely class of sharp object was only stated when there was good history and wound characteristics. Any injury sustained to the palm, fingers, hands, and forearms in a position that may have been used as a defense against an attack was considered a defense-type injury. Using the available history and medicolegal records, the reported circumstances of injury were grouped into interpersonal assault, accidental, and self-inflicted. These classifications were for analytical purposes only and were not considered final intent classifications.

Multidisciplinary Assessment

Physiological parameters were deduced from the initial clinical and laboratory evaluation; the surgical team documented the clinical and operative findings, and a predefined set of wound-morphology criteria was used to evaluate the forensic characteristics. The three domains were then combined to recognize if specific wound patterns led to a more pronounced physiological drop and higher clinical severity. By doing so, characteristics of anatomical injuries were compared to systemic physiological responses and anatomical forensic patterns in the same patient population.

Study Outcomes

Major emergency surgery, intensive care unit admission, transfusion of ≥2 units of packed red blood cells, and in-hospital mortality were the primary outcome events. The individual components of the composite endpoint, major vascular or visceral injury, and length of hospital stay were secondary outcomes. The relationship between forensic features, physiological abnormalities, anatomical severity of injuries, and adverse clinical outcomes was assessed in particular.

Statistical Analysis

The collected data were analysed using IBM SPSS 26.0 software. Data for continuous variables were presented as mean ± standard deviation or median and interquartile range, and data for categorical variables were presented as frequencies and percentages. The independent-samples t-test, Mann–Whitney U test, chi-square test, or Fisher's exact test, as appropriate, were used to compare clinical, physiological, and forensic variables between patients with adverse and non-adverse outcomes, respectively. Multivariable logistic regression was used to determine independent clinical, physiological, and forensic factors that predicted adverse outcomes. Adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated, and P values < 0.05 were taken as statistically significant (2-sided).

Ethical Considerations

The ethical permissions of the participating centers' institutional review authorities were secured. All patient information was anonymized prior to analysis, and the confidentiality of clinical and medicolegal information was upheld throughout the study.

RESULTS

A total of 120 patients with sharp-force injuries were included. The mean age was 32.4 ± 11.2 years, and 98 (81.7%) were male. 82 (68.3%) cases of interpersonal assault were the most common setting in which an injury occurred. Stab wounds were the most common type of wound in 87 (72.5%) patients, and 46 (38.3%) had multiple wounds. There were 49 (40.8%) patients with major visceral or vascular injury, and 31 (25.8%) with ISS ≥16. Baseline demographic, clinical, and forensic features are provided in Table 1.

The most commonly affected anatomical site was the upper limbs (40 patients, 33.3%), followed by the thorax (32 patients, 26.7%) and abdomen (27 patients, 22.5%). Although they occurred less frequently, abdominal injuries were most clinically serious, with 18

(66.7%) patients having major visceral or vascular injury, and 22 (81.5%) undergoing operation. Table 2 also revealed that there was a relatively high incidence of internal injury and surgical management in thoracic injuries.

A high percentage of patients were physiologically compromised at presentation. The mean heart rate was 97.8 ± 19.6 beats/minute, mean systolic blood pressure was 113.6 ± 21.9 mmHg, and mean shock index was 0.87 ± 0.25. A shock index >0.9 was recorded in 32 (26.7%) patients, while 28 (23.3%) were hemodynamically unstable. Serum lactate exceeded 2 mmol/L in 36 (30.0%) patients. In total, 63 (52.5%) patients needed surgery, 33 (27.5%) needed blood transfusion, 22 (18.3%) needed intensive care unit admission, and 6 (5.0%) died in hospital. Physiological findings and clinical outcomes are shown in Table 3.

Forty-five (37.5%) patients had a composite adverse outcome as predefined. Adverse outcomes had significant increases in the degree of physiological and anatomic injury severity. Shock index >0.9 occurred in 27 (60.0%) patients with adverse outcome and in 5 (6.7%) patients without adverse outcome, $p<0.001$. Likewise, associations were found with serum lactate elevation, hemodynamic instability, ISS ≥16, major visceral or vascular injury, and thoracoabdominal involvement. A greater number of wounds was also linked to poor outcomes, whereas defense-type injuries were not significantly linked to clinical deterioration.

In multivariable logistic regression, shock index >0.9, serum lactate >2 mmol/L, Injury Severity Score ≥16, and major visceral or vascular injury remained independently associated with adverse outcomes. The results of these are summarized in Table 4.

Discrimination of the multivariable model was good (AUC 0.87), and calibration was acceptable (Hosmer–Lemeshow p-value 0.62). In summary, the results suggest that the adverse outcome was mainly influenced by the combination of physiological compromise and anatomical injury severity, with the forensic characteristics adding context as to injury pattern and reported circumstances.

Table 1. Baseline Clinical and Forensic Characteristics of Patients

Variable	**n (%) / Mean ± SD**
Age, years	32.4 ± 11.2
Male	98 (81.7)
Female	22 (18.3)
Interpersonal assault	82 (68.3)
Accidental injury	24 (20.0)
Self-inflicted injury	14 (11.7)
Predominantly stab wounds	87 (72.5)
Predominantly incised wounds	33 (27.5)
Multiple wounds	46 (38.3)
Defense-type injuries	29 (24.2)
Major visceral/vascular injury	49 (40.8)
Injury Severity Score ≥16	31 (25.8)

Table 2. Anatomical Distribution, Physiological Severity, and Operative Requirement

Predominant Injury Site	**Total n (%)**	**Major Internal/Vascular Injury n (%)**	**Shock Index >0.9 n (%)**	**Operative Intervention n (%)**
Upper limb	40 (33.3)	7 (17.5)	5 (12.5)	12 (30.0)
Thorax	32 (26.7)	15 (46.9)	10 (31.3)	18 (56.3)
Abdomen	27 (22.5)	18 (66.7)	12 (44.4)	22 (81.5)
Head and neck	12 (10.0)	5 (41.7)	3 (25.0)	7 (58.3)
Lower limb	9 (7.5)	4 (44.4)	2 (22.2)	4 (44.4)
Total	**120 (100)**	**49 (40.8)**	**32 (26.7)**	**63 (52.5)**

Table 3. Physiological Parameters and Clinical Outcomes

Variable	Value
Heart rate, beats/minute	97.8 ± 19.6
Systolic blood pressure, mmHg	113.6 ± 21.9
Shock index	0.87 ± 0.25
Shock index >0.9	32 (26.7%)
Hemodynamic instability	28 (23.3%)
Hemoglobin, g/dL	11.8 ± 2.0
Hemoglobin <10 g/dL	25 (20.8%)
Serum lactate, mmol/L, median (IQR)	1.9 (1.3–3.1)
Serum lactate >2 mmol/L	36 (30.0%)
Operative intervention	63 (52.5%)
Blood transfusion	33 (27.5%)
≥2 units packed red blood cells	20 (16.7%)
Intensive care unit admission	22 (18.3%)
Median hospital stay, days	4 (2–7)
In-hospital mortality	6 (5.0%)

Table 4. Factors Associated with Adverse Clinical Outcomes and Multivariable Analysis

Variable	Adverse Outcome n=45	No Adverse Outcome n=75	p-value	Adjusted OR (95% CI)
Shock index >0.9	27 (60.0%)	5 (6.7%)	<0.001	5.18 (1.84–14.57)
Lactate >2 mmol/L	28 (62.2%)	8 (10.7%)	<0.001	4.27 (1.58–11.54)
Hemodynamic instability	23 (51.1%)	5 (6.7%)	<0.001	—
Hemoglobin <10 g/dL	18 (40.0%)	7 (9.3%)	<0.001	—
Injury Severity Score ≥16	24 (53.3%)	7 (9.3%)	<0.001	3.91 (1.42–10.76)
Major visceral/vascular injury	33 (73.3%)	16 (21.3%)	<0.001	4.63 (1.71–12.52)
Thoracoabdominal injury	32 (71.1%)	27 (36.0%)	<0.001	2.41 (0.95–6.11)
Multiple wounds	23 (51.1%)	23 (30.7%)	0.026	1.57 (0.61–4.05)
Defense-type injury	14 (31.1%)	15 (20.0%)	0.167	1.19 (0.43–3.27)

DISCUSSION

The present study provides an integrated assessment of sharp-force injuries by examining their clinical severity, physiological consequences, and forensic characteristics within the same patient population[1]. Results showed that sharp force trauma was more common in young adult males and was most often related to interpersonal violence. Stab wounds were the most common type of wound found, and upper-limb, thoracic, and abdominal areas were the main anatomical areas involved. Importantly, the anatomical severity of the injury was not necessarily correlated with the clinical severity, with the abdominal and thoracic injuries being associated with significantly higher rates of major abdominal and thoracic trauma and surgery[2,3].

An important conclusion of this study was that there was a strong relationship between physiological deterioration and adverse clinical outcomes[4]. The shock index proved to be highly predictive of the need for major intervention, intensive care support, or large amounts of blood transfusion in patients with a shock index >0.9. This is a reminder of the utility of the shock index as a quick bedside guide in penetrating or incised trauma, especially when the amount of external blood loss does not match the amount of internal blood loss. Its simplicity and the fact that it's always available for initial assessment further support its usefulness[5].

Serum lactate also showed an important correlation with the clinical severity. Patients who had a lactate > 2 mmol/l had significantly worse outcomes than patients with a lactate < 2 mmol/l. An increased lactate level in sharp-force trauma could be an indication of decreased tissue perfusion due to bleeding,

blood vessel damage, or progressive circulatory shock. Physiological assessment may provide valuable prognostic information that is independent of anatomical wound description, as lactate remained a predictor after multivariable adjustment[6,7].

Anatomical injury severity was still a significant factor. Morbidity was significantly greater in patients with ISS ≥16 and those with major visceral or vascular involvement[8]. The highest observed need for surgery was for abdominal wounds, in which the potential for solid organ, hollow viscera, and major intra-abdominal vessel penetration is greatest. Wounds of the thorax were also at great risk, as a small external wound could be related to pneumothorax, hemothorax, pulmonary laceration, or vascular injury. The conclusion, in turn, confirms the rule that the superficial appearance of a sharp force injury should not be the only guide to the severity of the injury[9].

The forensic results added a different, but complementary, side to the analysis. Injuries to the defense were more likely to be found with patients who had suffered interpersonal assault, especially those to the hands and forearms[10]. Assault-related presentations were also more likely to have multiple injuries and stab wounds. But defense wounds alone were not significant predictors of poor clinical outcome. This is significant as the forensic wound description may be helpful in determining the circumstances of a wound without necessarily indicating the physiological or anatomic severity[11].

There was significant overlap between the forensic patterns of assault related, accidental, and self-inflicted injuries. Therefore, it is not always possible to draw a definite conclusion about intention or method of wounding from any single wound feature[12]. These factors wound number, location, orientation and morphology should be taken in conjunction with the clinical history, medicolegal investigation and other available evidence. Objective description is also of special importance, as speculation in the clinical record can influence subsequent forensic or judicial assessment[13].

The multidisciplinary approach to the present study also shows that clinical, physiological and forensic data offer various types of information, and these are more valuable when used together[14]. Anatomical assessment provides information about structures at risk, physiological parameters supply information about the systemic injury, and forensic examination provides information about the wound pattern and possible circumstances. This integration could enhance early risk stratification, in addition to creating more extensive medicolegal documentation[15].

The results of the multivariable analyses also corroborate this integrated approach. Shock index, elevated lactate, high Injury Severity Score, and major visceral or vascular injury remained independently associated with adverse outcomes. By contrast, several wounds and defence-related injuries were of low importance when adjusted, implying that the immediate prognosis of sharp force injuries was more influenced by the physiological compromise and anatomical injury than by the forensic pattern[16-18].

There are some limitations to the study. It was done in two institutions with a relatively small sample size, limiting generalizability. Details of the mechanism and circumstances of the injury were partly reliant on the history of the patient/attendant and could not always be independently verified. A forensic assessment was conducted in the clinical environment and not as a full scene-based investigation. Long-term functional, physiologic, and medicolegal outcomes were not assessed. Larger multicenter studies using standardized forensic documentation of wound morphology may yield more evidence of the relationship between the wound morphology and physiological deterioration and patient outcomes[19,20].

CONCLUSION

Sharp-force injuries are also a complicated injury type in which anatomical injuries, physiological disturbance, and forensic characteristics must be considered. Shock index >0.9, elevated serum lactate, Injury Severity Score ≥16, and major visceral or vascular injury were the strongest independent predictors of adverse clinical outcomes. The odds of an operative procedure and internal injury were especially high for thoracic and abdominal injuries. Forensic characteristics like defense wounds and multiple wounds were more useful for contextual information and less for predicting clinical severity. It is believed that using a multidisciplinary approach involving surgical evaluation, physiological risk stratification, and objective documentation of the forensic evidence may aid in optimizing patient management and medicolegal assessment of sharp force trauma.

Author Contributions

MAA and SA conceived and designed the study. MYK and SZM contributed to data collection and clinical assessment. HH and SAW contributed to physiological and forensic evaluation. MAA, SA, and MYK analyzed and interpreted the data. SA and SZM drafted the manuscript. All authors critically reviewed, revised, and approved the final manuscript.

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