International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

Descriptive Study of Blunt Chest Trauma, Its Diagnosis, Management and Complications

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Abstract: ***Blunt chest trauma continues to represent a leading public health and emergency surgical challenge worldwide, carrying high morbidity and treatment resource utilization rates within young and productive civilian populations. This study evaluates the clinical markers, diagnostic frameworks, management modalities, and complications of blunt thoracic injuries inside a busy tertiary care teaching facility. An 18-month descriptive observational study evaluated 60 admitted patients with blunt chest trauma under standard Advanced Trauma Life Support protocols. Data demonstrated a mean cohort age of 38.93 ± 15.87 years with a sharp 3:1 male predominance (75.0%). Road traffic accidents were the single largest mechanism of mechanical injury (58.3%), followed closely by accidental falls from height (16.7%). Over 88% of cases presented with intense chest wall pain, while 50.0% had associated respiratory dyspnea. Skeletal injury was present in 55.0% of cases, with multiple rib fractures spanning up to 6 distinct rib segments. Intrathoracic manifestations mapped via CECT thorax identified simple or tension pneumothorax in 18.3%, localized pulmonary contusions in 16.7%, and acute hemothorax in 10.0%. Universal multimodal analgesia combined with targeted chest physiotherapy allowed for high non-operative success (78.3%), whereas intercostal tube thoracostomy was executed in 20.0% of cases. Intensive care units hosted 28.3% of the cohort. Statistical analyses confirmed a highly significant, absolute association between admission peripheral hypoxia (SpO_2 < 90%) and intensive care support requirements ($p < 0.001$), as well as a significant link between pulmonary contusion and prolonged hospitalizations ($p = 0.042$). Effective early chest drainage, analgesia, and physiotherapy are core pillars that improve lung re-expansion and streamline inpatient care pathways.***

Keywords: Blunt chest trauma, Rib fractures, Pulmonary contusion, Tube thoracostomy

1. Introduction

Trauma represents an escalating global pandemic that accounts for immense public health expenditures, dynamic working-age morbidity, and structural productivity losses across multi-centric socioeconomic landscapes. Among different variants of mechanical impacts, thoracic trauma holds an exceptionally critical position because the chest cavity encloses primary vital structures required for cardiopulmonary homeostasis, including the lungs, heart, major vascular configurations, and mediastinal channels [1]. Mechanical injuries sustained across these frameworks can precipitously disrupt ventilation, systemic circulation, and oxygen diffusion, demanding rapid diagnosis and systematic resuscitation to prevent immediate mortality [2].

Thoracic trauma is split into penetrating wounds and blunt force impacts. In civilian emergency departments-particularly within rapidly urbanizing countries like India-blunt chest trauma is overwhelmingly more common and is routinely linked with high-velocity road traffic accidents, industrial crush injuries, mechanical occupational hazards, domestic falls, and physical assaults [3]. Blunt thoracic injuries are characterized by force propagation across the chest cage and internal soft tissues without any disruption of the overlying skin or structural soft tissue boundaries [4]. The kinetic energy transmitted through direct compression, high-speed deceleration, or rotational shearing often yields complex pathophysiological transformations within the pulmonary parenchyma and pleural zones before clinical signs become fully apparent [5].

The clinical spectrum is incredibly wide, ranging from basic soft tissue wall contusions and minor isolated rib fractures to highly fatal entities like tension pneumothorax, massive hemothorax, unstable flail chest, progressive pulmonary contusion, cardiac tamponade, and traumatic diaphragmatic or aortic rupture [6]. Rib fractures are the most frequent bone injuries and act as clinical markers for the sheer energy volume absorbed by the body [7]. Multiple rib fractures induce intense pain, causing immediate splinting, reductions in vital volume, weak cough reflexes, and subsequent retention of bronchial mucus. If left unmanaged, these patterns lead to atelectasis, secondary nosocomial pneumonia, profound hypoxemia, and acute respiratory distress syndrome [8]. This descriptive study maps the local profile, radiological injury patterns, treatment methods, and complications within a tertiary care hospital in Western India, providing institutional evidence to optimize emergency general surgery protocols.

2. Materials and Methods

An institutional descriptive observational study was carried out over an 18-month duration in the Department of General Surgery at a tertiary care teaching facility in Western India. The study methodology systematically tracked the clinical pathways, diagnostic profiles, procedures and secondary complications of admitted blunt chest trauma victims without changing the standard institutional protocols or standard Advanced Trauma Life Support (ATLS) practices.

2.1 Selection and Eligibility Criteria

The target framework comprised all mechanical trauma cases presenting via the emergency casualty room, outpatient surgical clinics, or direct internal referrals with a validated history of blunt force trauma directed at the thorax. Cases were accrued based on precise eligibility criteria:

Inclusion Criteria: Patients presenting with an absolute history of blunt chest trauma requiring formal hospital admission for systematic evaluation, continuous monitoring, or surgical/medical management, across all age brackets, sexes, and occupations, who provided signed informed written consent.

Exclusion Criteria: Patients presenting with open penetrating thoracic wounds; minor chest wall contusions not requiring formal inpatient tracking; critical polytrauma patients who expired during active emergency resuscitation before primary diagnostics were completed; cases who left against medical advice (LAMA) before full baseline evaluation; or records containing incomplete master chart information.

2.2 Resuscitation and Clinical Protocol

At emergency triage, all subjects immediately underwent rapid primary surveys and baseline resuscitation adhering strictly to ATLS concepts, prioritizing the immediate stabilization of the Airway, Breathing, and Circulation (ABC) axis. Advanced airway control or endotracheal intubation was performed for patients exhibiting airway compromise or severe neurological depression. Continuous supplemental oxygenation was initiated via face masks or nasal cannula for individuals with respiratory distress or low saturation levels. Large-bore intravenous access was established immediately, and fluid resuscitation with isotonic crystalloids was adjusted according to continuous blood pressure and pulse readings.

Following primary surveys, a comprehensive secondary evaluation captured the mechanism of impact, elapsed time since trauma, alcohol ingestion patterns, comorbidities, and presenting symptoms. Local chest evaluation systematically mapped tenderness, asymmetrical wall movements, soft tissue abrasions, bone crepitus, subcutaneous surgical emphysema, and tracheal alignment. Baseline blood panels tracked complete blood counts, typing, blood sugar, and renal/hepatic indices. Standard 12-lead electrocardiography (ECG) and chest radiography (CXR) were performed for all patients. Bedside Extended Focused Assessment with Sonography for Trauma (eFAST) was used to check for immediate pleural air/fluid or free abdominal fluid. Stable patients with high-energy mechanisms, severe localized tenderness or abnormal plain radiographs underwent contrast-enhanced computed tomography (CECT) of the thorax for exact injury mapping.

2.3 Statistical Analysis

The final patient-wise database was analyzed using Microsoft Excel and SPSS Software. Categorical distributions and qualitative metrics were summarized as absolute frequencies and percentages. Continuous variables were expressed as mean values, standard deviations (± SD), absolute ranges, and median values. Subgroup associations were evaluated via cross-tabulations using the Chi-square test or Fisher's exact test depending on subgroup sizes. Continuous measurements across subsets were compared via the independent Student’s t-test. Statistical significance thresholds were established at $p < 0.05$, while highly significant indicators were marked at $p < 0.001$.

3. Results

The dataset captured a total of 60 consecutive patients matching the inclusion parameters. A comprehensive extraction of continuous variables is organized in Table 1 below.

Table 1: Summary of Baseline Continuous Metrics

Variable Parameters	Mean	± SD	Range	Median
Age (years)	38.93	15.87	8 – 71	37.00
Time Since Injury (hrs)	16.57	14.93	1 – 48	11.00
Pulse Rate (/min)	101.87	12.31	82 – 130	104.00
Systolic BP (mmHg)	108.62	11.96	76 – 129	109.00
Diastolic BP (mmHg)	67.03	7.93	50 – 81	67.00
Respiratory Rate (/min)	24.33	3.93	18 – 36	24.00
Admission SpO_2 (%)	91.80	3.33	82 – 98	91.00
GCS Score	14.05	1.24	10 – 15	14.00
Fractured Rib Count	1.65	1.89	0 – 6	1.00
Hospital Stay (days)	6.70	4.84	2 – 20	5.00

Age-stratified groups showed that blunt thoracic injuries peaked in active adults: 31–40 years had 17 patients (28.3%), and 21–30 years had 14 patients (23.3%). Younger cases ≤20 years accounted for 5 patients (8.3%), while older sets aged 41–50, 51–60, and >60 years constituted 11 (18.3%), 7 (11.7%), and 6 cases (10.0%), respectively. The cohort showed a sharp gender skew, with males making up 75.0% (n = 45) and females 25.0% (n = 15) of admissions, establishing a 3:1 male-to-female ratio. Occupation analysis showed physical laborers were the largest set (18.3%, n = 11), followed by students (15.0%, n = 9), retired individuals (13.3%, n = 8), and farmers, shopkeepers, and business owners at 10.0% each (n = 6 each).

Table 2: Trauma Mechanisms and Symptoms Breakdown

Clinical Index Parameters	Count (n=60)	Ratio (%)
Etiological Mechanism		
Road Traffic Accident	35	58.3%
Fall from Height	10	16.7%
Physical Assault	6	10.0%
Animal-Related Injury	4	6.7%
Direct Blunt Object Hit	3	5.0%
Occupational Crush	2	3.3%
Presenting Complaints		
Chest Pain	53	88.3%

Breathlessness / Dyspnea	30	50.0%
Abdominal Pain	11	18.3%
Cough	9	15.0%
Altered Sensorium	7	11.7%
Vomiting	5	8.3%
Hemoptysis	3	5.0%

Table 2 notes that road traffic accidents led all etiologies (58.3%). Chest pain dominated subjective symptoms (88.3%), followed by acute breathlessness (50.0%). Bedside secondary surveys mapped widespread chest wall tenderness in 90.0% (n = 54), restricted or reduced chest movements in 71.7% (n = 43), skin abrasions or soft tissue contusions in 66.7% (n = 40), palpable bony rib crepitus in 43.3% (n = 26), subcutaneous surgical emphysema in 20.0% (n = 12), and active tracheal shift in 5.0% (n = 3).

Associated extra-thoracic injuries were frequent across the sample: concurrent head trauma occurred in 30.0% (n = 18), abdominal visceral injuries in 21.7% (n = 13), limb fractures/extremity trauma in 10.0% (n = 6), and focal spinal fractures in 1.7% (n = 1), outlining a heavy polytrauma mix. Universal diagnostics involved 12-lead ECG and chest radiographs for 100.0% of the cohort, focused eFAST sonography in 58.3% (n = 35), and advanced CECT chest sweeps in 78.3% (n = 47) of stable patients.

Table 3: Thoracic Injury Patterns and Treatments

Injury Variant & Procedures	Count (n=60)	Ratio (%)
Specific Thoracic Injuries		
Rib Fracture (Any)	33	55.0%
Multiple Rib Fractures	27	45.0%
Subcutaneous Emphysema	13	21.7%
Pneumothorax	11	18.3%
Pulmonary Contusion	10	16.7%
Pleural Effusion	10	16.7%
Hemothorax	6	10.0%
Sternal Fracture	3	5.0%
True Flail Chest	1	1.7%
Therapeutic Modalities		
Analgesics (Universal Protocol)	60	100.0%
Supplemental Oxygen	54	90.0%
Chest Physiotherapy / Spirometry	51	85.0%
Conservative Management Only	47	78.3%
Intravenous Antibiotics	40	66.7%
Intravenous Fluids	36	60.0%
Intensive Care Unit (ICU) Care	17	28.3%
Intercostal Drainage (ICD) Tube	12	20.0%
Operative Surgical Intervention	7	11.7%
Mechanical Ventilation	3	5.0%

Specific injury combinations mapped in Table 3 identified rib fractures in 55.0% (n = 33), with multiple rib fractures present in 45.0% (n = 27). Rib count distributions showed 27 cases (45.0%) without bone fractures, 6 cases (10.0%) with 1 fracture, 8 cases (13.3%) with 2 fractures, 8 cases (13.3%) with 3 fractures, 5 cases (8.3%) with 4 fractures, 3 cases (5.0%) with 5 fractures, and 3 cases (5.0%) with 6 fractures. Intrathoracic manifestations mapped pneumothorax in 18.3%, pulmonary contusions in 16.7%, and hemothorax in 10.0%. Multi-modal pain management was used in 100.0% of cases, while non-invasive conservative tracking succeeded in 78.3% (n = 47). Intercostal tube thoracostomy was performed in 12 cases (20.0%), divided equally between the right (n = 6) and left (n = 6) hemithoraces, with a mean insertion stay of 7.58 days. Secondary complications tracked during admission showed respiratory distress in 31.7% (n = 19), respiratory failure in 10.0% (n = 6), atelectasis in 5.0% (n = 3), and nosocomial pneumonia in 5.0% (n = 3). Favorable recovery was achieved, with 91.7% (n = 55) discharged in completely stable condition, 3.3% (n = 2) improved, and 5.0% (n = 3) referred or in poor status. Zero in-hospital deaths occurred.

Table 4: Statistical Evaluation of Key Outcomes

Predictor Marker	ICU: Yes	ICU: No	Test / Sign.
Pulmonary Contusion on CECT			
Contusion Present	7 (70.0%)	3 (30.0%)	Fisher's Exact
Contusion Absent	10 (20.0%)	40 (80.0%)	$p = 0.003$
Admission Hypoxia ($SpO_2 < 90\%$)			
Hypoxia Present	10 (100%)	0 (0.0%)	Fisher's Exact
Hypoxia Absent	7 (14.0%)	43 (86.0%)	$p < 0.001$
Predictor Marker	Stay > 7d	Stay ≤ 7d	Test / Sign.
Tube Thoracostomy (ICD Required)			
ICD Executed	12 (100%)	0 (0.0%)	Fisher's Exact
ICD Omitted	7 (14.6%)	41 (85.4%)	$p < 0.001$
Intensive Care (ICU Required)			
ICU Care Given	12 (70.6%)	5 (29.4%)	Fisher's Exact
ICU Care Omitted	7 (16.3%)	36 (83.7%)	$p < 0.001$

Bivariate testing in Table 4 confirmed a highly significant link between admission hypoxia ($SpO_2 < 90\%$) and the need for ICU placement ($p < 0.001$), with all 10 hypoxic cases requiring intensive care. Pulmonary contusion also correlated significantly with ICU triage ($p = 0.003$). For resource tracking, both ICD execution and ICU requirements showed highly significant links with prolonged hospital stays over 7 days ($p < 0.001$).

Table 5: Hospital Length of Stay (LOS) Associations

Clinical Parameter	Stay (Days) if Present	Stay (Days) if Absent	t-test p-value
ICD Insertion	14.25 ± 4.18	4.81 ± 2.68	< 0.001
ICU Admission	11.59 ± 5.28	4.77 ± 2.97	< 0.001
Secondary Complication	9.21 ± 5.56	5.03 ± 3.47	< 0.001
Pulmonary Contusion	8.90 ± 4.23	6.26 ± 4.88	0.042
Rib Fracture (Any)	6.24 ± 4.62	7.26 ± 5.13	0.524
Multiple Rib Fractures	6.70 ± 4.90	6.70 ± 4.88	0.742

Table 5 compares length of stay variations across key parameters. Inpatient stay was significantly extended by chest tube interventions (14.25 days vs. 4.81 days, $p < 0.001$) and ICU requirements (11.59 days vs. 4.77 days, $p < 0.001$). Evolving secondary complications and contusions also prolonged stays. However, the presence of isolated or multiple rib fractures showed no statistically significant effect on hospital duration ($p = 0.524$ and $p = 0.742$), reflecting effective pain management and respiratory protocols.

4. Discussion

Blunt chest trauma remains a primary focus within emergency general surgery and public health epidemiology, as minor external chest wall signs can easily obscure major internal thoracic injuries. The elastic properties and compliance of the chest wall allow substantial kinetic force to pass directly into pleuropulmonary networks and vascular channels, starting a destructive cycle of ventilation-perfusion mismatch, local bleeding, and systemic hypoxia [1,2].

The demographic patterns in this cohort match long-term trends recorded across major Indian trauma databases. The mean age of 38.93 years and the concentration of cases between 21 and 40 years represent the most mobile, active, and outdoor-exposed segment of the population. This active working-age pattern matches findings by Gupta et al. in Western India, who noted high rates of outdoor work and transport risks, as well as trauma analyses by Narayanan et al. at a major urban level 1 facility [9]. The 3:1 male-to-female ratio mirrors other standard regional samples, reflecting high male participation in commercial transport, heavy labor, agricultural activities, and high-risk environments. This specific occupational risk is reinforced by our data, where physical laborers and students formed the largest subgroups, highlighting the socioeconomic impact of temporary disability, treatment costs, and lost working days [11,12].

Mechanistically, road traffic accidents led all causes of blunt chest trauma (58.3%), followed by accidental falls from height (16.7%). This specific distribution matches contemporary Indian reports by Singh et al. and Walia et al., where vehicular decelerations and direct impact forces were the primary causes of thoracic injuries. The high rate of transport injuries is tied to growing road networks, high travel speeds, mixed traffic, and low compliance with protective devices like seatbelts and helmets. Falls from height highlight risks on regional construction sites and farming layouts, as well as low-energy domestic falls in older patients with reduced bone density and narrow physiological reserve [11,12].

A key finding from this evaluation is the value of admission physiological parameters for early risk routing. Admission hypoxia ($SpO_2 < 90\%$) showed an absolute, highly significant correlation with intensive care requirements ($p < 0.001$), with all 10 hypoxic cases requiring urgent ICU placement for advanced oxygen delivery and monitoring. This confirms that a simple pulse oximetry check at triage acts as an immediate indicator of severe injury, identifying significant pleuropulmonary or airway compromise before complex imaging is arranged [15,16].

Radiologically, rib fractures were the most frequent findings (55.0%), with multiple fractures in 45.0%. While standard medical texts often link high rib fracture counts with secondary infections and mortality, our analysis showed that the presence of single or multiple rib fractures alone did not significantly extend the total hospital length of stay ($p = 0.524$ and $p = 0.742$). This indicates that bone fractures alone do not dictate care duration when managed under proper clinical pathways. This success reflects our institutional pain management protocol, which was used in 100.0% of cases. Early and continuous analgesia controls chest wall pain, prevents splinting, improves breathing depth, and supports active chest physiotherapy (used in 85.0% of cases), minimizing the complications usually caused by rib injuries [17,18].

Conversely, parenchymal injuries were major drivers of overall morbidity. Pulmonary contusion (16.7%) showed a significant link with both ICU admission ($p = 0.003$) and longer hospital stays ($p = 0.042$). This matches the delayed pathophysiology of lung contusions, which involve progressive capillary leaks, fluid accumulation, and localized inflammation peaking between 24 and 48 hours. This course matches warnings by Ganie et al. and Mahmood et al. that initial plain films often underestimate contusion volume, requiring close respiratory tracking, careful fluid management, and targeted oximetry to prevent sudden respiratory deterioration [19-20]. Pleural collections like pneumothorax and hemothorax required chest tubes in 20.0% of cases, which significantly extended hospital stays ($p < 0.001$) due to the need for monitoring drainage, air leaks, and lung expansion. The absence of empyema or long-term leaks confirms proper procedure technique within the safe triangle, avoiding the complications described by DuBose et al. [21,22]. The zero in-hospital mortality reflects early presentation times (63.3% within 12 hours) and structured multidisciplinary care [23, 24].

5. Conclusion

This study demonstrates that blunt chest trauma primarily affects young and middle-aged adult males, with road traffic accidents and falls from height acting as the main causes. While rib fractures are the most common skeletal injuries, they do not extend hospital stays when managed with effective multi-modal pain control and early breathing exercises. Instead, hospital length of stay and intensive care requirements are driven by underlying lung contusions and the need for chest tube drainage. At triage, an admission oxygen saturation below 90% is a sensitive and powerful predictor of the need for intensive care. Implementing structured trauma care pathways—focused on early oximetry screening, prompt advanced imaging, optimized fluid use, and targeted tube thoracostomy—is essential to reduce respiratory complications, optimize resource use, and support excellent patient recovery.

6. Limitations of the Study

This study possesses clear structural limitations that must be noted when interpreting the results. First, the modest sample size of 60 cases from a single tertiary institution may restrict the direct generalizability of the findings to broader regional or national trauma frameworks. Second, the single-center design reflects localized transport patterns, referral pipelines, and institutional resources. Third, the hospital-based selection excluded minor thoracic contusions that did not require formal admission, as well as critical polytrauma victims who died in the resuscitation bay before primary diagnostics were finalized. Fourth, the short follow-up window limited the tracking of long-term post-discharge complications, such as chronic neuropathic pain, malunion, or permanent functional changes. Finally, concurrent polytrauma (such as severe head or abdominal injuries) acted as a confounding factor that could influence intensive care requirements and length of stay independently of the thoracic injuries.

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