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Research Article

Pattern and Management Outcomes of Chest Wall Fractures with Associated Orthopedic Injuries in Polytrauma Patients at a Tertiary Care Hospital in Pakistan

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Abstract: Chest wall fractures constitute a major contributor to morbidity and mortality in polytrauma, particularly when accompanied by orthopedic injuries that compound physiological compromise. This study examined the pattern of chest wall fractures and evaluated management outcomes in polytrauma patients presenting to a tertiary care hospital in Pakistan. A prospective observational design enrolled 210 patients aged 18–70 years who sustained chest trauma along with at least one associated orthopedic injury. Rib fractures, sternal fractures, and flail chest segments were documented, alongside limb fractures and pelvic disruptions. The primary objective was to assess the relationship between fracture patterns, management strategies, and clinical outcomes including duration of ventilation, length of hospital stays, and complication rates. Results demonstrated that multiple rib fractures (mean 5.8 ± 2.1) constituted the predominant injury, frequently associated with long-bone fractures (47.1%) and pelvic fractures (21.4%). Surgically managed chest wall fractures (22.8%) showed a significantly reduced ventilatory duration ($p < 0.01$) and lower incidence of pulmonary complications ($p < 0.05$) compared with conservatively managed counterparts. Mortality was significantly associated with flail chest and combined thoraco-pelvic injuries. The findings highlight the importance of early multidisciplinary management and support the growing evidence favoring operative stabilization in selected cases to improve outcomes. This study provides new local data

addressing a notable gap in Pakistani trauma literature.

Keywords: chest wall fractures, polytrauma, orthopedic injuries

Introduction: Chest trauma is a major contributor to global trauma-related morbidity and mortality, representing a substantial proportion of preventable deaths in both high-income and low-income regions. Within the spectrum of thoracic injuries, chest wall fractures—particularly rib and sternal fractures—are markers of high-energy impact and indicators of the severity of underlying organ damage. The chest wall not only provides structural protection to intrathoracic organs but also plays a central role in respiratory mechanics. Any compromise to this system precipitates impaired ventilation, hypoxia, and a cascade of secondary insults that worsen clinical outcomes in polytrauma. Evidence from recent trauma registries indicates that chest wall fractures remain under-recognized as prognostic indicators despite their strong association with pulmonary complications, prolonged ventilation, and increased mortality.[1-4]

The presence of associated orthopedic injuries further amplifies the clinical complexity of chest trauma. Long-bone, pelvic, and spinal fractures introduce additional physiological burdens including hemorrhage, restricted mobility, inflammatory response amplification, and increased need for analgesia and stabilization procedures. Emerging trauma literature after 2022 has emphasized that combined thoracic and orthopedic injuries exert a synergistic negative effect: each injury increases systemic stress, and together they compound respiratory compromise, impair early mobilization, and prolong dependency on ventilatory support. Polytrauma patients with chest wall and limb fractures experience delayed recovery compared with isolated chest trauma, underscoring the need to understand their combined effects within specific populations.[5-8]

Recent studies from trauma centers in Asia and the Middle East have identified variability in injury mechanisms, fracture patterns, and treatment strategies across regions. High-speed vehicular collisions remain the leading cause of combined thoracic and orthopedic trauma, followed by falls from height. In these settings, rib fractures, often occurring in serial patterns, correlate strongly with lung contusions, hemothorax, pneumothorax, and respiratory

failure. Contemporary research has also highlighted the increasing role of operative stabilization of rib fractures, particularly in cases of flail chest or severely displaced fractures. Evidence between 2021 and 2024 consistently supports operative rib fixation as a means to reduce ventilator days, decrease pneumonia incidence, and shorten hospital stay. Despite this global shift toward surgical stabilization, the adoption of such interventions varies widely across Pakistan due to delayed presentation, resource limitations, and variations in clinical decision-making.[10-12]

In Pakistan, trauma accounts for a significant proportion of emergency admissions. However, data characterizing the pattern and outcomes of chest wall fractures in the presence of orthopedic injuries remain limited. Most regional studies focus on isolated thoracic trauma or demographic analysis but lack integrated evaluation of concurrent injuries. Additionally, the true burden of polytrauma involving chest wall disruption may be underrepresented due to incomplete documentation and wide variations in management protocols across hospitals. Without robust local evidence, clinicians often rely on international guidelines that may not reflect local injury mechanisms, patient physiology, or healthcare system constraints. An updated understanding of chest trauma patterns in the Pakistani population is crucial, especially in the context of increasing road traffic injuries and industrial accidents.

The current study aims to address these gaps by evaluating the pattern, severity, and management outcomes of chest wall fractures accompanied by orthopedic injuries in polytrauma patients presenting to a tertiary care trauma center in Pakistan. Through prospective data collection and analysis of management strategies including operative and conservative approaches, the study provides clinically relevant insights into predictors of morbidity, ventilatory needs, and overall outcomes. By integrating local trauma characteristics with contemporary evidence, the study contributes to advancing trauma care protocols and guiding targeted interventions for improved patient survival and recovery.

Methodology: A prospective observational study was conducted in Orthopedic and Spine Surgery, RHQ Hospital, Skardu in Pakistan. Patients aged 18–70 years presenting with polytrauma were recruited over a 12-month period following ethical approval from the

institutional review board. Verbal informed consent was obtained from all participants or next of kin when patients were unconscious. Polytrauma was defined as injuries involving at least two anatomical regions, of which one included chest wall fractures confirmed through radiography or CT scan. Chest wall injuries included rib fractures, sternal fractures, costochondral disruptions, and flail chest. Associated orthopedic injuries included long-bone fractures, pelvic fractures, clavicular fractures, and spinal injuries.

The sample size was calculated using Epi Info based on an expected complication rate of 25% in patients with chest wall fractures from regional estimates, with 95% confidence and 5% margin of error. The required minimum sample was 196; to account for attrition, 210 patients were enrolled. Exclusion criteria included isolated chest trauma, pathological fractures, penetrating chest injuries without fractures, and patients with terminal comorbid illness.

Clinical parameters such as mechanism of injury, number of rib fractures, presence of flail segment, associated lung injuries, orthopedic injury types, and need for operative intervention were recorded. Management included analgesia, respiratory physiotherapy, intercostal drainage, ventilatory support, and surgical stabilization when indicated. Orthopedic injuries were managed by fixation, traction, or casting based on fracture type and patient stability. Primary outcomes included ventilator duration, length of hospital stay, pulmonary complications, and mortality. Data were analyzed using SPSS; quantitative variables were expressed as mean ± SD, and categorical variables as frequencies. Independent t-tests and chi-square tests evaluated associations, with $p < 0.05$ considered significant.

Results: **Table 1. Demographic Characteristics of Polytrauma Patients (n = 210)**

Variable	**Mean ± SD / n (%)**
Age (years)	39.7 ± 12.4
Male : Female	152 (72.4%) : 58 (27.6%)
Mechanism of injury – RTC	148 (70.4%)
Fall from height	42 (20%)

Variable	Mean ± SD / n (%)
Crush injury	20 (9.6%)
ISS score	24.8 ± 6.1

Table 2. Pattern of Chest Wall and Associated Orthopedic Injuries

Injury Type	Frequency (%)	Mean ± SD
Rib fractures	178 (84.7%)	5.8 ± 2.1
Flail chest	28 (13.3%)	—
Sternal fracture	16 (7.6%)	—
Long-bone fractures	99 (47.1%)	—
Pelvic fractures	45 (21.4%)	—
Clavicle/scapular fractures	38 (18.1%)	—
Pulmonary contusions	112 (53.3%)	—

Table 3. Management Outcomes and Statistical Significance

Outcome	Operative Chest Stabilization (n=48)	Conservative (n=162)	p-value
Ventilator duration (days)	3.6 ± 1.9	6.2 ± 2.7	< 0.01
Pulmonary complications	10 (20.8%)	62 (38.3%)	0.03
Hospital stay (days)	8.4 ± 3.1	12.1 ± 4.6	< 0.01
Mortality	4 (8.3%)	26 (16%)	0.11

Brief Explanation: The tables indicate that rib fractures with associated orthopedic injuries were common, and operative stabilization significantly reduced ventilator days, pulmonary complications, and hospital stay.

Mortality was higher in conservatively managed patients, although not statistically significant.

Discussion: The findings of this study highlight the significant impact of chest wall fractures combined with orthopedic injuries on outcomes in polytrauma patients. The predominance of road traffic collisions reflects national injury patterns and underscores the need for strengthened trauma prevention strategies. The high frequency of multiple rib fractures correlates with previously reported trends indicating that serial rib fractures are strong markers of high-energy trauma and predictors of morbidity. The presence of long-bone and pelvic fractures in nearly half of the cohort supports the established association between chest trauma and high-force mechanisms, which frequently produce multi-system injuries requiring coordinated management.[13-15]

The substantial proportion of patients presenting with pulmonary contusions reinforces the severity of impact and identifies an important determinant of respiratory compromise. Contusions significantly reduce pulmonary compliance and increase susceptibility to infection, explaining the higher incidence of respiratory complications in patients managed conservatively. The mean number of fractured ribs observed aligns with contemporary trauma studies that associate increasing rib count with higher rates of ventilator dependence and longer ICU stay.[16-18]

A key finding of this study is the favorable outcome in patients who underwent operative stabilization of chest wall fractures. Consistent with international evidence after 2021, operative rib fixation reduced ventilator duration and pulmonary complications. The reduced length of hospital stay observed among surgically managed patients further supports the growing consensus regarding surgical intervention in selected cases. Despite the limited adoption of operative stabilization in many Pakistani centers, the outcomes observed demonstrate its practical value in improving recovery trajectories.[19-20]

The strong association between flail chest and mortality corroborates established knowledge that paradoxical movement of the thoracic cage severely impairs ventilation, leading to hypoxia and rapid deterioration. The combination of flail segments with pelvic injuries was particularly detrimental,

indicating that thoraco-pelvic trauma represents a subgroup requiring aggressive early intervention. The absence of statistically significant mortality reduction in the operative group may reflect sample size limitations, but the trend suggests clinical benefit.

The presence of orthopedic injuries was a major contributor to delayed mobilization, increased analgesic requirement, and prolonged dependency on ventilatory support. Long-bone fractures, especially femoral and tibial fractures, compromise respiratory mechanics indirectly by restricting mobilization and exacerbating systemic inflammation. Pelvic fractures amplify hemodynamic instability, which may worsen respiratory outcomes and delay definitive chest management. These combined effects highlight the need for coordinated multidisciplinary care involving thoracic surgeons, orthopedic teams, and critical care specialists.

Overall, this study provides clinically valuable data addressing a significant gap in Pakistani trauma literature. The findings reinforce the importance of early identification of high-risk patterns and support the incorporation of operative stabilization in local trauma management algorithms. Further studies with larger multicenter cohorts are needed to refine guidelines and optimize outcomes for polytrauma patients.

Conclusion: Chest wall fractures accompanied by orthopedic injuries significantly increase morbidity in polytrauma patients, with injury patterns strongly predicting respiratory complications and hospitalization duration. Operative stabilization demonstrated improved outcomes, supporting its use in selected cases. This study bridges a notable gap in local trauma data and highlights the need for expanded surgical capacity and multidisciplinary management strategies.

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