



## THE BURDEN OF ISOLATED THORACIC TRAUMA IN INDIA: A 7-YEAR RETROSPECTIVE ANALYSIS OF 794 PATIENTS

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### Abstract

**Background:** Thoracic trauma accounts for 15–25% of severe trauma admissions globally, with high mortality rates in resource-limited settings. Despite advances in imaging and interventions, isolated thoracic injuries remain understudied, particularly in low- and middle-income countries. **Objective:** This study analyses the epidemiology, management strategies, and outcomes of isolated thoracic trauma at a tertiary care centre in India.

**Methods:** A retrospective cohort analysis was conducted on 794 patients with isolated chest trauma (blunt or penetrating) admitted between July 2018 and June 2025. Data included demographics, injury mechanisms, interventions (e.g., tube thoracostomy, thoracotomy), pain management, and complications. Statistical analysis employed descriptive and inferential methods (t-tests, chi-square). **Results:** Of 1,905 trauma admissions, 41.7% (n=794) had isolated thoracic injuries, predominantly blunt trauma (91.7%). Road traffic accidents (52%) and falls (16.2%) were the leading causes. Only 6% presented within the "golden hour." Common injuries included multiple rib fractures (91%), pneumothorax (39.1%), and haemothorax (60.9%). Intercostal drainage was performed in 84%, while surgical rib fixation was notably absent despite flail chest in 7.4% of cases. Mortality was 4.6%, associated with age >50 years, delayed admission, and mechanical ventilation.

**Conclusion:** Isolated thoracic trauma carries significant morbidity, with outcomes influenced by timely intervention and multimodal analgesia. Underutilization of surgical rib fixation and regional anaesthesia highlights gaps in adherence to global guidelines. Standardized protocols incorporating early stabilization and advanced pain management may improve outcomes in resource-limited settings.

**Keywords:** Thoracic trauma, rib fractures, flail chest, trauma outcomes, India, retrospective study.

### Introduction

Trauma remains a critical global public health challenge, with the World Health Organization (WHO) reporting it as the leading cause of death among individuals aged 5–44 years worldwide.<sup>1</sup> In India, the trauma burden has escalated dramatically, with road traffic injuries alone accounting for 11% of global trauma mortality.<sup>2</sup> This surge correlates strongly with rapid urbanization, increased vehicular

density (156 vehicles per 1000 population as per 2023 Ministry of road transport and highway of India (MoRTH data), and industrial growth.<sup>3</sup>

Thoracic trauma constitutes 15-25% of all severe trauma admissions in tertiary care centers, with mortality rates exceeding 20% in cases involving multiple rib fractures.<sup>4</sup> Contemporary studies demonstrate that 82-94% of thoracic trauma cases can be managed effectively with basic interventions like tube thoracostomy when performed within the "golden hour".<sup>5</sup> However, outcomes vary significantly between high-income countries and resource-limited settings like India, where delays in prehospital care increase preventable deaths by 35%.<sup>6</sup>

The ability to understand thoracic injuries better has not only reduced the mortality attributable to these injuries, but has also significantly reduced morbidity. Industrial advances, such as the advent of CT scanning, MRI, and thoracoscopy, has enabled the thoracic surgeon to better understand and diagnose patients who have sustained significant thoracic trauma. Majority of available literature pertained to multisystem injured trauma patients. In contrast, there has been a paucity of research on rib fractures in isolated thoracic trauma. Therefore, this study is designed to retrospectively analyses previous 07 years of institutional data on isolated thoracic trauma

### **Material and methods**

A retrospective cohort analysis was conducted at a 210-bed Level I Trauma Center, evaluating outcomes of patients admitted with isolated thoracic trauma (blunt or penetrating) between July 2018 and June 2025. Institute's Ethics Committee approval obtained for the study protocol. The study adheres to the STROBE guidelines of reporting observational studies. All patients with isolated thoracic trauma either blunt or penetrating were included in the study. Patients who were brought dead or died during resuscitation, poly trauma, associated extra thoracic injuries and patients having incomplete records or lost to follow up were excluded from the study. Case records were examined to identify demographic information, including age, gender, mechanism of injury, hemodynamic status, transfusion requirements, computed tomography (CT) scan results, time elapsed between the initial diagnosis and surgery, length of hospital and intensive care unit (ICU) stay, number of days spent on a ventilator, complications, and final outcome. All patients received initial treatment in accordance with the Advance Trauma Life Support guidelines (ATLS) and the principles of Damage Control Resuscitation. Primary and secondary surveys were performed, and high-resolution computed tomography (CT) with 3-D reconstruction was obtained for a detailed assessment of thoracic injuries. Apart from radiological investigations thorough physical examination was done to identify life threatening thoracic injuries. Chest-tube insertion was performed in patients with pleural complications and in those with severe subcutaneous emphysema and prominent dyspnoea, even if there was no evidence of pneumothorax in the chest X-ray. Thoracotomy was performed if the initial chest tube output was >1500 ml or the hourly output was 200 ml for 4 h. For purposes of our study, thoracotomies performed within 4 h of admission were recorded as 'early', while thoracotomy performed after 4 h was termed 'late'. Hemodynamically unstable patients were transferred directly to the operating theatre for open emergency thoracotomy, while hemodynamically stable patients had been treated conservatively. Blunt trauma is defined as injuries in which organs and structures are injured without destroying the integrity of the tissue. A flail chest is characterized by the fracture of three or more adjacent ribs in at least two locations. Mortality is defined as death occurring during hospitalization, either from the trauma incident or from complications emerging thereafter. The duration of ICU stay is described as the interval from admission to the ICU until transfer from the ICU. The hospital stay is described as the duration from admission to discharge or death within the hospital. Ventilation hours are defined as the duration the patient has been subjected to mechanical ventilation. Hemithorax is defined as fluid between the visceral and parietal pleura that is 50% or more of the haematocrit of the peripheral blood or having 35-70 Hounsfield unit on CT chest. Retained haemothorax is defined as residual blood clots of 500 mL remaining in the pleural cavity after 72 hours of chest drainage. Video assisted thoracoscopic surgeries were performed for retained haemothorax. The Easter scoring system is used to assess morbidity, while the pain, inspiration, and cough reflex score is used to guide nonsurgical treatment. Pain management was done with oral

nonsteroidal anti-inflammatory drugs (NSAIDs), paracetamol 650 mg orally three times daily, or 1 g IV three times daily; opioids (morphine 10-20 mg twice daily, IV 0.1-0.2 mg/kg), and pregabalin 75 mg twice daily. Regional anaesthesia is administered using an ultrasound-guided block of the erector spinae for posterior rib fracture. The initial loading dose of ropivacaine was set at 30 mL, followed by an infusion of 0.1% at 7 mL/hour with fentanyl at 1 µg/kg. The serratus anterior block is administered at the same dose as anterior rib fractures. For bilateral rib fractures, an epidural block with ropivacaine 0.2 in a dose of 10 mL is given, followed by an infusion of 5 mL/hour and fentanyl at 1 µg/kg.

The acquired data have been analysed statistically employing descriptive statistics, including mean, median, and mode. The quantitative data were examined using the Student's t-test, while the qualitative data were evaluated using the chi-square test. The magnitude of the association has been demonstrated by the adjusted odds ratio (AOR) with a confidence interval (CI) of 95%. p values below 0.05 have been recognized as significant. The Kruskal-Wallis H test has been employed to compare the time taken to get to the hospital.

## Results

Of all trauma admissions, 1905 patients (34.2%) had thoracic injuries. Out of these 794 patients (41.7%) had isolated thoracic injuries. A male-to-female ratio of 5:1 has been observed among the patients, with 662 (83.4%) being male patients and 132 (16.6%) being female patients. The patients' ages ranged from 10 to 83 years old, with an average age of 41.62 years. The age range of 20-48 years comprised the majority of patients, 566 (71.3%). In 728 patients (91.7%), blunt trauma was the most prevalent mechanism of injury; penetrating thoracic trauma had been reported by the remaining 66 patients (8.3%). In 413 patients (52%), traffic accidents constituted the prevalent trauma type, followed by falls from height (128; 16.2%), assault (94; 11.9%), low-energy falls (79; 10%), sports injuries (16; 2%), and others (63; 8%). Only 48 patients (6%) were admitted within the "golden hour," while the majority were reached up to 24 hours after the injury. Of the 794 patients, 666 (83.9%) were hemodynamically stable, while 128 (16.1%) were hemodynamically unstable. One hundred sixty-six patients (21%) reported subcutaneous emphysema at the time of presentation, and 65% (516) of patients had a positive chest X-ray. Single rib fractures were observed in 71 patients (9.1%), while multiple rib fractures occurred in 723 patients (91%). Unilateral thoracic injuries were observed in 567 (71.5%) and bilateral injuries in 227 patients (28.5%). Flail chest was found in patients 59 (7.4%). Pneumothorax was found in 310 patients (39.1%), haemothorax in 484 (60.9%), and pneumohemothorax in 113 patients (14.3%). Overall, the mean injury severity score (ISS) has been  $17.18 \pm 5.51$  with a median of 11. For blunt trauma, the mean ISS was  $15.16 \pm 6.5$ , while for penetrating trauma, it was  $14.7 \pm 4.8$ . intercostal tube drainage (ICD) insertion had been the most frequently performed surgical procedure in 666 (84%), unilateral in 526 (79%), and bilateral in 140 (21%). Tracheostomy was performed in 53 patients (6.6%) for prolonged ventilation. Respiratory support was provided to 447 patients (56.4%). Of these 447 patients, 371 (83%) only required oxygen by mask. Eleven patients (2.4%) required non-invasive ventilation, while 65 patients (14.5%) were intubated and ventilated. Resuscitative thoracotomy was performed in two patients (0.25%) who had shock and pulseless electrical activity after penetrating injury. Thoracotomy was performed in 23 patients (2.8%). Video-assisted thoracoscopic surgery, either for retained haemothorax or empyema, was performed in 12 patients (1.5%). All cases of rib fractures, as well as flail chest were managed without rib fixation. A multimodal strategy was chosen to treat pain. NSAIDs and systemic opioids were administered to 571 patients (72%), while 223 (28%) received regional anaesthesia. Of these 223 patients, 64 (29%) received a serratus anterior block, 82 (37%) received an erector spinae block, and 77 (34.5%) received epidural anaesthesia. Of the 794 patients with thoracic injuries, 507 (63.8%) were treated without complications, whereas approximately 36.1% (287) suffered complications during hospitalization.

The average ICU stay was 26 days, ranging from 1 to 43 days. twenty-two patients (2.91%) had to be readmitted to the ICU. The median hospital stay was 18 days (1-64). The overall mortality rate was 37 (4.6%)

Mortality had been notably associated with increasing age, evidenced by 21 patients (57%) in the geriatric (age >50 years) group. The mortality rate among patients after surgery had been 35% (08 patients). The number of deaths within six hours of admission was 6 (16.2%), within 24 hours was 10 (27%), within 72 hours was 17 (45.9%), and after 72 hours was 4 (10.8%). The immediate cause of death was severe haemorrhagic shock, while type 1 respiratory failure and sepsis led to death in patients after 72 hours. Results of our research indicate the relationship among age, admission timing, penetrating injuries, bilateral chest injuries, and the necessity for mechanical ventilation

## Discussion

In this retrospective cohort study of 794 patients with isolated thoracic trauma over a seven-year period, we observed that multiple rib fractures (91%) and blunt injuries (91.7%) constituted the majority of chest trauma cases. The overall mortality rate was 4.6%, with the highest risk in patients aged >50 years, those presenting late (>1 hour post-injury), with bilateral injuries, penetrating trauma, and those requiring mechanical ventilation. Our findings align with global literature indicating that these factors significantly influence morbidity and mortality in chest trauma patients.<sup>7,8</sup>

Despite flail chest being present in 7.4% of cases, no patient underwent rib fixation. Evidence increasingly supports surgical stabilization of rib fractures (SSRF) in patients with flail chest or multiple displaced ribs. A 2024 consensus by the World Society of Emergency Surgery (WSES) and Chest Wall Injury Society (CWIS) recommends SSRF within 72 hours, showing reductions in pneumonia, ventilator days, and ICU stay.<sup>9</sup> Studies also show SSRF decreases mortality by nearly 60% in isolated thoracic trauma, particularly in older and ventilated patients.<sup>10,11</sup> Given the average ICU stay in our study was 26 days, implementing SSRF could significantly improve outcomes.

Only 6% of patients presented within the golden hour, reflecting substantial prehospital care delays. Prior literature suggests that early intervention within the golden hour reduces preventable trauma deaths by up to 35%, particularly in resource-limited settings like India.<sup>12</sup> In our study, delayed admission correlated with higher mortality, notably within the first 72 hours post-injury, during which 17 patients (45.9%) died.

Pain control strategies in our cohort included NSAIDs and opioids in 72% of patients and regional anaesthesia in 28%, including serratus anterior block, erector spinae plane block, and epidural analgesia. While effective, recent studies advocate for broader use of ultrasound-guided regional blocks and cryoablation to reduce opioid use, improve pulmonary mechanics, and expedite recovery.<sup>13</sup> In our cohort, regional techniques were underutilized, particularly in high-risk flail chest cases.

Pneumothorax (39.1%), haemothorax (60.9%), and pneumohemothorax (14.3%) were common radiological findings. Intercostal chest drain (ICD) insertion was performed in 84%, reflecting its central role in thoracic trauma care. Thoracotomies were performed in 2.8%, with 12 patients (1.5%) undergoing video-assisted thoracoscopic surgery (VATS) for retained haemothorax or empyema. These figures are consistent with the literature, where timely VATS is associated with reduced hospital stay and infection rates.<sup>14</sup>

Overall, 36.1% of patients experienced complications, including respiratory failure, empyema, or sepsis. These complications were more common in older patients, those with bilateral injuries, and those requiring prolonged mechanical ventilation. Our study confirms earlier findings that injury severity, comorbidity burden, and inadequate pain control are predictors of poor outcomes.<sup>15</sup>

The mean Injury Severity Score (ISS) in our cohort was 17.18, higher in blunt trauma cases. Notably, only 0.25% underwent emergency resuscitative thoracotomy, reflecting its rare but critical indication in patients with hemodynamic collapse after penetrating trauma.<sup>16</sup>

## Limitations

Our study is limited by its retrospective, single-centre nature and lack of a control group for comparing SSRF or advanced analgesia. Long-term functional outcomes and quality-of-life measures were not assessed. Future prospective studies are needed to evaluate the impact of early SSRF and multimodal analgesia on morbidity and long-term recovery.

## Conclusion

Isolated thoracic trauma, although manageable with non-operative methods in most cases, presents a high burden of morbidity, especially in the presence of flail chest, bilateral injury, or delayed presentation. SSRF and advanced regional anaesthesia remain underutilized in such settings. Incorporation of standardized protocols, timely intervention, and wider adoption of evidence-based surgical and analgesic strategies may significantly reduce complications, improve outcomes, and shorten ICU and hospital stays.

## Funding

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