Current Thoracic Surgery

To cite this article: Can A, Sen H, Tiske MA, Sahinoglu T, Yildiran H. Evaluation of thoracic injuries resulting from two major earthquakes in Turkey. Curr Thorac Surg 2025;10(3):147-153.

Original Article

Evaluation of thoracic injuries resulting from two major earthquakes in Turkey

Atilla Can[1]*, Halil Şen[2], Muhammet Ali Tiske[1], Tuba Şahinoğlu[1], Hüseyin Yıldıran[1]

[1]Department of Thoracic Surgery, Selçuk University Faculty of Medicine, Konya, Turkey
[2]Department of Thoracic Surgery, University of Health Sciences, Beyhekim Training and Research Hospital, Konya, Turkey

ABSTRACT

Background: Earthquakes are sudden and destructive natural disasters with significant health implications. Thoracic injuries are among the most prevalent and serious trauma types due to their high morbidity and mortality rates. This study aimed to evaluate the clinical features, types of injuries, and management processes of thoracic trauma cases following the February 6, 2023, earthquakes in Turkey.

Materials and Methods: The study was conducted at a tertiary trauma center and included 14 patients. Data on age, gender, types of trauma, chest trauma score (CTS), duration of entrapment under debris, and associated injuries were analyzed. Statistical analyses were performed using SPSS version 21.0 with appropriate parametric and non-parametric tests.

Results: The mean age of patients was 43.64 ± 16.58 years, with 64.3% female and 35.7% male. The most common injuries were rib fractures (57.1%), hemothorax (35.7%), and crush syndrome (28.6%). The mean CTS was 3.50 ± 2.68, and 80% of patients with CTS scores above 5 had significant complications. Entrapment duration under debris was shorter in older patients, showing a statistically significant negative correlation with age (Spearman's rho = -0.568, p = 0.034). Prolonged entrapment was associated with longer hospital stays (Spearman's rho = 0.634, p = 0.015).

Conclusion: Earthquake-related thoracic injuries represent serious medical challenges that require multidisciplinary approaches and early interventions. The CTS proved effective in assessing trauma severity and guiding clinical priorities. Entrapment duration and age were identified as critical factors influencing patient prognosis, emphasizing their importance in post-disaster healthcare planning. Future studies with larger samples are needed to further investigate these relationships.

Keywords: chest trauma, earthquake injuries, hemothorax, rib fracture, thoracic injuries

Corresponding Author*: Atilla Can, MD. Department of Thoracic Surgery, Selçuk University Faculty of Medicine, Konya, Turkey.
E-mail: atillacan_ac@yahoo.com Phone: +90 5355557436
Doi: 10.26663/cts.2025.025
Received 01.11.2025 Accepted 05.12.2025

Introduction

Earthquakes are sudden and destructive natural disasters that cause profound effects on both human life and the environment. The physical impact of earthquakes extends beyond the destruction of buildings and infrastructure; they also pose serious threats to human health.

Turkey is located in one of the world's most seismically active zones, frequently experiencing major earthquakes due to the presence of significant fault lines, such as the North Anatolian Fault and the East Anatolian Fault. Consequently, large-scale earthquakes periodically occur in Turkey, leading to substantial loss of life and property. Past disasters, such as the 1999 İzmit Earthquake and the 2020 İzmir Earthquake, have highlighted the country's vulnerability to seismic events and the inevitability of such natural catastrophes.

On February 6, 2023, two devastating earthquakes, each exceeding magnitude 7 on the Richter scale, struck southern Turkey within a nine-hour interval. These earthquakes affected a vast region encompassing 10 provinces, resulting in more than 40,000 fatalities and over 100,000 injuries. While the primary impact of earthquakes is associated with mortality, a significant number of survivors sustain various traumatic injuries. Among the most common earthquake-related injuries are severe fractures, internal organ damage, crush syndrome, burns, limb traumas, abdominal injuries, head traumas, and thoracic injuries [1].

Thoracic trauma, particularly pneumothorax and rib fractures, is a major clinical concern in post-earthquake injuries. Additionally, prolonged entrapment under rubble can lead to severe systemic complications, including compartment syndrome, renal failure, and hypovolemic shock. Thoracic injuries resulting from earthquakes constitute a critical aspect of disaster- related medical challenges. These injuries can occur due to multiple mechanisms, with the most common being direct trauma from collapsing structures or debris impact. Such blunt forces can lead to severe thoracic fractures and internal organ injuries. Moreover, panic- induced movements during seismic activity can contribute to additional traumatic injuries.

Studies indicate that approximately 10% of earthquake survivors experience thoracic and/or pulmonary injuries. The most prevalent types of injuries vary depending on the mechanism of trauma; however, individuals trapped beneath completely collapsed buildings and subjected to prolonged compression are at a higher risk of developing pneumothorax and rib fractures [2]. Despite advancements in treatment modalities, thoracic trauma remains associated with high morbidity and mortality rates. Specifically, thoracic trauma accounts for 10-15% of all trauma cases and 7.6-15.9% of earthquake-related injuries [3-5].

This study retrospectively analyzes the clinical characteristics and treatment outcomes of patients presenting with thoracic trauma following the February 6, 2023, Turkey earthquakes at our hospital.

The aim of this study is to evaluate the clinical features, injury patterns, and treatment outcomes of patients who sustained thoracic trauma following the February 6, 2023, earthquakes in Turkey.

Materials and Methods

This study was conducted as a retrospective analysis at a tertiary healthcare center, focusing on patients affected by the February 6, 2023 earthquakes. The primary aim was to evaluate the clinical characteristics and treatment processes of patients who sustained thoracic trauma following the earthquakes. The study was approved by the local ethics committee and institutional administration.

Patients admitted to our hospital between February 8 and February 28, 2023 were screened for eligibility. Earthquake-related thoracic trauma cases were identified through medical records. Earthquake-related injury was defined using objective criteria, including documentation of collapse-related mechanisms, confirmed extrication from debris, transfer from earthquake-affected provinces, or explicit notation such as "earthquake-related injury" in physician or emergency medical service reports. All eligible cases were verified independently through electronic medical record review to ensure accurate classification.

Patients whose injuries had no clear association with the earthquake or had an uncertain etiology were excluded. Entrapment under debris was also recorded and analyzed, although it was not used as an inclusion criterion. The duration of entrapment was obtained from patient or family statements, prehospital rescue documentation, and emergency medical service transfer records, when available.

This study was approved by Ethics Committee of Selçuk University, Noninvasive Clinic Ethics Committee (Approval date: 04.06.2024; Number: 2024/285.)

Statistical Analysis

Statistical analysis of medical data was performed using SPSS version 21.0 (Statistical Package for Social Sciences, SPSS Inc., USA). This software was chosen due to its extensive set of tools for both parametric and non-parametric statistical analyses. For continuous variables, the minimum, maximum, mean ± standard deviation, median, first quartile, and third quartile values were calculated. Categorical variables were summarized using frequency distributions and percentage values. To assess the assumption of normality, the Shapiro-Wilk normality test was conducted. The results indicated that continuous variables, such as age and duration of entrapment under debris, did not follow a normal distribution ($p < 0.05$). Therefore, non-parametric statistical methods were employed for further analyses. For variables exhibiting normal distribution, Pearson's correlation coefficient was used, while for non-normally distributed data, Spearman's rank correlation coefficient was calculated. A statistical significance level of 5% ($p < 0.05$) was applied to all analyses.

Results

A total of 14 patients were included in the study, with a mean age of 43.6 ± 16.6 years (range: 21–82 years). Gender distribution: 64.3% of the patients were female (n = 9), while 35.7% were male (n = 5). The mean age of female patients was slightly lower than that of male patients. This age difference was also associated with differences in the duration of entrapment under debris, with female patients exhibiting longer entrapment durations compared to their male counterparts.

Distribution of trauma types

Rib Fractures: Multiple rib fractures were detected in 42.9% of patients, while 14.3% had a single rib fracture, and 42.9% had no rib fractures at all (Figure 1, Figure 2). Patients with multiple rib fractures frequently exhibited pneumothorax and/or hemothorax. This suggests that severe rib fractures are associated with significant pulmonary damage, intrathoracic pressure changes, and higher rates of pneumothorax and hemothorax (Table 1).

Pneumothorax was observed in 14.3% of the patients. All affected patients required tube thoracostomy to manage lung collapse and restore intrathoracic pressure. Tube thoracostomy effectively alleviated respiratory distress and ensured favorable outcomes.

Hemothorax was detected in 35.7% of patients (Figure 3). The majority of these patients required tube thoracostomy to drain intrapleural blood and restore lung expansion. One patient was managed conservatively, as the hemothorax was minimal. Tube thoracostomy remains the standard intervention for hemothorax, preventing complications and supporting pulmonary function.

Sternal fracture was identified in 7.1% of patients, often associated with severe trauma. In the affected patient, sternal fracture was accompanied by multiple rib fractures, hemothorax, pneumothorax, and pulmonary contusion. These findings highlight the high-energy mechanism of such injuries, which affect both the thoracic wall and intrathoracic organs. The patient required tube thoracostomy, which effectively regulated intrathoracic pressure and improved respiratory status. Sternal fractures emphasize the need for rapid and effective interventions, given their frequent association with severe thoracic injuries.

Crush Syndrome was diagnosed in 28.6% of patients, primarily linked to prolonged entrapment under debris and high-energy trauma. Characterized by prolonged muscle compression, crush syndrome led to systemic complications, including myoglobinemia, hyperkalemia, acute kidney injury, and metabolic acidosis. Patients with crush syndrome frequently exhibited concurrent thoracic trauma, such as hemothorax, pneumothorax, or pulmonary contusion. These findings underscore the systemic impact of severe trauma and highlight the necessity of a multidisciplinary approach in managing these patients effectively.

Chest trauma score

The chest trauma score (CTS) is a scoring system designed to predict outcomes in patients with blunt chest trauma. CTS evaluates age, the number of rib fractures, the severity of pulmonary contusion, and the presence of bilateral rib fractures to generate a total score. The scores range from 2 to 12, with higher scores being associated with worse clinical outcomes. The CTS calculation table is presented in Table 2. This scoring system serves as a practical tool for early intervention in trauma patients [6].

The mean CTS score in our study was 3.5 ± 2.7. Among patients with CTS scores above 5, 80% were found to have additional trauma or complications. Higher CTS

scores were associated with longer ICU stays, increased pneumothorax incidence, and higher complication rates, reflecting the impact of trauma severity on clinical outcomes. These findings support the potential utility of CTS in stratifying trauma patients based on severity, aiding in early risk assessment and clinical decision-making.

Normality testing showed that only age was normally distributed, while entrapment duration, hospital stay, and CTS did not follow a normal distribution (Table 3). Correlation analyses revealed no statistically significant relationship between CTS and age ($\varrho = -0.18$, $p = 0.53$), entrapment duration ($\varrho = -0.12$, $p = 0.67$), or hospital stay ($\varrho = 0.21$, $p = 0.47$). Confidence intervals for these correlations were wide, reflecting the small sample size (Table 4). To explore the relationship between specific thoracic complications and CTS, non-parametric comparisons were conducted using the Mann-Whitney U test. Among the binary variables examined (pneumothorax, hemothorax, contusion, crush syndrome, tube thoracostomy, and ICU admission), only pulmonary contusion was significantly associated with higher CTS scores ($p = 0.045$). No other significant associations were observed (Table 5).

Duration of entrapment under debris

The duration of entrapment for the patients in this study ranged from a minimum of 0 hours to a maximum of 72 hours, with a mean duration of 14.9 ± 21.9 hours. These durations exhibited a wide distribution, with the longest entrapment time recorded as 72 hours.

A statistically significant negative correlation was found between age and duration of entrapment (Spearman's rho = -0.568, $p = 0.034$). This finding suggests that as age increases, the duration of entrapment tends to decrease.

Additional injuries and intensive care unit requirements

Among the patients, 50% did not exhibit any additional injuries, whereas 14.3% presented with associated injuries, including pelvic fractures and scapular fractures. These types of additional injuries were predominantly observed in patients subjected to high-energy trauma mechanisms, highlighting the systemic impact of severe trauma. The presence of additional injuries complicated clinical management and necessitated a multidisciplinary approach to patient care.

A total of 21.4% of patients required intensive care unit (ICU) admission. Among those requiring intensive care, intrathoracic pathologies such as pneumothorax and hemothorax were frequently detected. This suggests that the severity of trauma and the extent of thoracic injuries significantly influenced the need for intensive care. Furthermore, the mean hospital stay was longer among patients admitted to the ICU compared to those who were not. This highlights that severe thoracic trauma prolongs recovery and requires comprehensive management.

These results suggest that earthquake-related thoracic trauma may extend beyond localized injuries and potentially involve systemic implications. The severity of trauma necessitates appropriate treatment strategies, early intervention, and prevention of complications, all of which are critical for optimizing patient outcomes.

Table 1. Distribution of trauma types in earthquake-related thoracic trauma patients.

Type of trauma	n	(%)
Rib fracture (multiple)	6	42.9
Rib fracture (single)	2	14.3
No rib fracture	6	42.9
Pneumothorax	2	14.3
Hemothorax	5	35.7
Crush Syndrome	4	28.6

Table 2. Chest trauma score (CTS) parameters and scoring criteria.

Parameter	Score
Age	
<45	1
45-65	2
>65	3
Pulmonary contusion	
None	0
Unilateral minor	1
Bilateral minor	2
Unilateral major	3
Bilateral major	4
Rib fracture	
<3	1
3-5	2
>5	3
Bilateral rib fracture	
No	0
Yes	2

Table 3. Normality test results (Shapiro-Wilk).			
Variable	Shapiro-Wilk statistic	p-value	Normally distributed (p > 0.05)
Age	0.9539	0.6225	Yes
Duration under debris	0.7370	0.0009	No
Hospital stay (days)	0.5663	0.0000	No
CTS score	0.8569	0.0276	No
Interpretation: Only age follows a normal distribution. Non-parametric tests were used for others.			

Table 4. Correlation between CTS and numerical variables (Spearman with 95% Confidence Interval).				
Variable	Spearman r	p-value	95% CI (lower)	95% CI (upper)
Age	-0.184	0.530	-0.667	0.330
Duration under debris	-0.125	0.671	-0.648	0.601
Hospital stay (days)	0.211	0.469	-0.356	0.750
Interpretation: None of the correlations were statistically significant (p > 0.05). Wide confidence intervals are due to small sample size.				

Table 5. Association between binary complications and CTS (Mann-Whitney U Test).				
Binary Variable	Median CTS (var)	Median CTS (yok)	Mann-Whitney U	p-value
Hemothorax	4.0	3.0	26.5	0.635
Pneumothorax	7.0	2.5	21.0	0.114
Contusion	8.0	3.0	21.5	0.045
Crush Syndrome	2.5	3.0	17.5	0.773
Tube Thoracostomy	5.0	2.5	29.0	0.221
Interpretation: Only contusion showed a statistically significant difference in CTS scores (p = 0.045).				

Discussion

This study contributes to the limited body of literature on the clinical outcomes of earthquake-related thoracic trauma and highlights the significance of structured assessment tools such as the CTS. The management of thoracic trauma in disaster settings is inherently complex, particularly due to challenges in timely access to healthcare and the high severity of crush- and debris-related injuries. Our findings demonstrate the relevance of entrapment duration, CTS, and coexisting injuries in shaping clinical outcomes. Compared with previous studies, the present analysis provides a focused examination of these prognostic factors.

Severe thoracic trauma related to prolonged entrapment is a critical concern in large-scale earthquakes, where mortality among trapped individuals is known to be high [7]. Although specific studies on earthquake-related thoracic trauma are scarce, data from blunt chest trauma indicate that one in three patients develops pneumothorax or hemothorax and more than half sustain pulmonary contusions [8]. These observations are consistent with our cohort, in which rib fractures were the most common injury, followed by hemothorax, pneumothorax, and pulmonary contusion. Prior research has shown that superficial lacerations and contusions are also frequently observed in trauma cases [9–11]. As the ribs represent the primary protective structure of the thoracic cage, disruption of this barrier increases the likelihood of intrathoracic complications. Our results align with existing literature in this regard.

Findings from previous earthquakes further contextualize our results. During the Kobe earthquake, 12.9% of evaluated patients had thoracic injuries, most commonly superficial wounds and rib or clavicular fractures [12]. Similarly, following the 2011 Van earthquake, multiple rib fractures were common, occurring in 46.2% of affected individuals [13]. Although injury rates differ by earthquake magnitude and rescue efficiency, our findings showed comparable proportions of rib fractures and multiple fractures.

In our study, the mean CTS was 3.50 ± 2.68. CTS has been consistently validated as a reliable metric for predicting outcomes in blunt thoracic trauma [14-16]. Prior studies have linked higher CTS values with increased rates of pneumonia, need for mechanical ventilation, longer ICU stay, and mortality [14,16,17]. Consistent with these findings, 80% of patients in our cohort with CTS >5 exhibited additional injuries or serious complications, most commonly pneumothorax.

Furthermore, higher CTS values were associated with a greater likelihood of ICU admission. These parallels reinforce the utility of CTS as an early risk-stratification tool in disaster-related thoracic trauma.

Entrapment duration was positively correlated with hospital length of stay, consistent with earlier studies reporting delayed transfers and prolonged hospitalization among individuals trapped for extended periods [21-23]. Research from the Marmara and Lushan earthquakes similarly emphasized the role of trauma severity and infection burden in prolonging recovery [22,24]. These findings collectively underscore the importance of rapid, well-coordinated rescue operations to reduce morbidity in earthquake victims.

In terms of the relationship between age and entrapment duration, previous literature reports lower survival rates among elderly individuals following prolonged entrapment [25]. In our cohort, older patients had shorter documented entrapment durations. This observation may reflect differences in survival patterns, rescue dynamics, or reporting accuracy rather than intrinsic physiological endurance alone. While definitive causal explanations cannot be drawn due to the small sample size, this finding highlights the relevance of early rescue efforts for elderly individuals.

The clinical implications of our findings are notable. CTS may serve as a rapid triage tool in mass-casualty scenarios to identify patients at higher risk for complications. Early tube thoracostomy for pneumothorax or hemothorax and timely preparation of ICU resources are essential components of disaster-related thoracic trauma management. Additionally, the association between prolonged entrapment and extended hospitalization emphasizes the importance of efficient triage and rescue systems. Integrating these insights into disaster preparedness strategies may improve outcomes in future earthquakes.

Limitations of the study

This study has several limitations. The single-center setting outside the earthquake zone and small sample size (n = 14) restrict generalizability and statistical power. Variability in entrapment duration, trauma severity, and pre-existing conditions further complicates interpretation. The presence of multi-trauma in some patients may also have influenced outcomes. Despite these constraints, the study provides valuable observations on the characteristics and management of earthquake-related thoracic injuries and contributes to the limited existing evidence.

In conclusion, this study evaluated the clinical characteristics and outcomes of thoracic trauma among patients affected by the February 6, 2023 earthquakes in Turkey. Entrapment duration, Chest Trauma Score (CTS), and the presence of associated injuries emerged as key factors influencing clinical course and resource needs. CTS demonstrated practical value in early risk stratification and may serve as a useful tool for guiding treatment priorities in disaster-related thoracic trauma.

Management of earthquake-related thoracic injuries particularly pneumothorax, hemothorax, and crush syndrome remains crucial for improving survival. Prolonged entrapment was associated with extended hospitalization, while older individuals had shorter documented entrapment durations, underscoring the importance of timely and efficient rescue operations.

These findings highlight the need to strengthen post-earthquake healthcare capacity, establish structured early intervention protocols, and adopt multidisciplinary management strategies. Larger multicenter studies are required to validate these observations and provide more robust evidence to inform clinical practice. Until such data become available, the conclusions of this study should be interpreted with caution due to the limited sample size and single-center design.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

Ethics Committee Approval

This study was approved by Ethics Committee of Selçuk University, Noninvasive Clinic Ethics Committee (Approval date: 04.06.2024; Number: 2024/285.)

Author Contributions

AC: Conception, design, resources, materials, data collection and processing, analysis and interpretation, literature search, writing manuscript, critical review. HŞ: Data collection, analysis and processing, literature search. MAT: Data collection, resources, materials. TŞ: Data collection, analysis and processing. HY: Supervision, design, critical review, analysis and interpretation.

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