Assessment of Chest CT Scan Findings in Multiple Trauma Patients Admitted to the Emergency Department of Khatam-al-Anbia Hospital in Zahedan in 2023

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Received: 2024-08-16; Received in revised form: 2025-01-21; Accepted: 2025-03-14

Abstract

Background: This study investigates the clinical predictors of chest CT scan findings in patients with chest trauma presenting to the emergency department of Khatam-Al-Anbia Hospital in Zahedan in 2023.

Methods: A cross-sectional study was conducted on 460 patients with multiple traumas. Data were collected from CT scan reports and analyzed using SPSS 22 software, employing independent t-tests, correlation coefficients, and chi-square tests.

Results: The mean age of the patients was 40.2 ± 20.36 years (range: 16–97). Gender distribution included 28.7% women and 71.3% men. Significant differences in CT scan findings were observed based on gender (P = 0.032), trauma mechanism (P = 0.029), and clinical complaint type (P = 0.017). Patients under 20 years old exhibited more normal findings, whereas those over 40 had a higher prevalence of rib and thoracic vertebra fractures. Traffic accidents and collisions frequently resulted in rib and thoracic vertebra fractures, while altercations were more commonly associated with pneumothorax. Clinical complaints of chest pain and deformity were frequently linked to pneumothorax and rib fractures.

Conclusions: These findings underscore the importance of age, trauma mechanism, and clinical complaints in diagnosing chest trauma, facilitating more informed decision-making and diagnosis.

Keywords: CT Scan Findings, Chest, Multiple Trauma, Emergency Department

Citation: Ziaei M., Dah madeh ei A., Bahmani A. **Assessment of Chest CT Scan Findings in Multiple Trauma Patients Admitted to the Emergency Department of Khatam-al-Anbia Hospital in Zahedan in 2023.** *Acad J Surg*, 2025; 8(1): 6-13.

Introduction

Trauma is a major cause of mortality worldwide, particularly in the first four decades of life [1, 2]. In Iran, trauma significantly contributes to death rates among young people [3]. A United Nations report highlights that Iran ranks first in traffic accident-induced trauma among several Asian and European countries [4]. Globally, trauma affects approximately 620 million people annually, resulting in 3.5 million deaths, predominantly from traffic accidents [5, 6]. In Iran, traffic-related trauma leads to 27,000–28,000 deaths each year [7], with 80% of these fatalities occurring among individuals aged 15–24 years, making it the leading cause of death for those aged 10–30 years [8, 9].

Trauma-related mortality is not confined to specific regions and continues to rise due to the increased use of motor vehicles. Thoracic trauma accounts for 25% of trauma-related fatalities [10]. In Iran, traffic accidents are cited as the most common cause of trauma [11]. Thoracic trauma is particularly critical due to its high mortality and morbidity rates, comprising 10–30% of all traumas and over 25% of trauma-related deaths [12–15]. It is primarily caused by motor vehicle accidents [16, 17] and is the third most common type of trauma after head and limb injuries [18, 19]. In the United States, thoracic trauma

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accounts for 20–25% of trauma-related deaths [20, 21].

Thoracic injuries, categorized into blunt and penetrating traumas, often result from motor vehicle accidents, falls, or assaults without penetrating wounds. Seventy percent of blunt thoracic traumas are caused by motor vehicle accidents [20, 21], whereas penetrating traumas typically result from stabbings or gunshots. Despite many such injuries being of moderate severity and rarely requiring surgical intervention, accurate diagnosis and monitoring remain crucial [24]. Initial assessment prioritizes airway, breathing, and circulation, with imaging techniques such as chest X-ray (CXR) and computed tomography (CT) playing vital roles in diagnosis and management [25–30]. CT is considered the gold standard for detecting thoracic injuries [26–28]; however, challenges such as time consumption, accessibility, and technical difficulties limit its use in emergency settings [32–35].

Trauma imposes significant economic burdens due to its impact on the young, productive population and the disabilities it causes. Notably, 40% of trauma-related deaths are preventable [8], underscoring the need for prompt and intensive care to mitigate long-term disabilities. Despite the critical nature of thoracic trauma, limited attention has been given to evaluating care delivery, causes, and treatment outcomes for these patients [36].

This study aims to identify clinical predictors of chest CT scan findings following chest trauma, addressing a gap in evidence-based indications for such scans. We examined chest CT scan results in multiple trauma patients admitted to the emergency department of Khatam-Al-Anbia Hospital in Zahedan in 2023 to determine which patients would benefit most from this diagnostic tool.

Methods

Study Design and Setting

This cross-sectional study was conducted in 2023 after the proposal was approved by the Research Council of the Faculty of Medicine and ethics clearance was obtained from the Ethics Committee of Zahedan University of Medical Sciences. The study took place at Zahedan University of Medical Sciences.

Among patients presenting with multiple trauma or isolated chest trauma to the emergency department of Khatam-al-Anbia Hospital in Zahedan, 490 cases were identified in the first six months of the year. Of these, 12 were excluded due to age criteria, 8 due to the absence of a CT scan request by the emergency medicine specialist, and 10 due to missing CT scan reports. The remaining cases were included in the study.

Data were collected using an information form, in which patient data were extracted based on CT scan reports and recorded. The records of all patients who presented with multiple trauma or isolated chest trauma to the emergency department of Khatam-al-Anbia Hospital in the first six months of 2023 were reviewed, resulting in the identification of 490 cases. After excluding 12 cases for age below 16 years, 8 cases due to the absence of a CT scan request, and 10 cases due to missing CT reports, the remaining cases were selected for the study.

Data Analysis

After data collection, the information was entered into SPSS version 22. Ethical considerations were observed by maintaining the confidentiality of patient information. Descriptive statistics, including frequencies, percentages, measures of central tendency, and measures of dispersion, as well as statistical tables and charts, were used to summarize the data. For data analysis, Chi-square tests or exact Chi-square tests were performed at a significance level of 0.05. Data were analyzed using SPSS version 22.

Result

In this study, chest CT scan findings were evaluated in 460 patients with multiple trauma admitted to the emergency department of Khatam-al-Anbia Hospital in Zahedan in 2023. Given the recurrence of certain findings in some individuals, apart from normal cases—which accounted for 239—a total of 387 findings were examined.

The mean age of the patients was 40.2 ± 20.36 years, ranging from 16 to 97 years. Regarding age distribution, 84 patients (17.6%) were under 20 years old, 189 patients (41.8%) were between 21 and 40 years old, and 187 patients (40.6%) were over 40 years old. In terms of gender distribution, 132 patients (28.7%) were female, while 328 patients (71.3%) were male.

Table 1 presents the findings from chest CT scans of patients who experienced multiple trauma or isolated chest trauma. The most common finding was a normal chest CT scan, observed in 239 patients, accounting for 51.9% of the cases. Rib fractures were the second most common finding, detected in 70 patients (15.2%). Pneumothorax was present in 59 patients, representing 12.8% of cases.

Subcutaneous emphysema was identified in 80 patients, constituting 17.4% of the study population. Hemothorax was less common, occurring in 9 patients

Table 1: Distribution of CT Scan Findings of the Chest in Multiple Trauma Patients

Chest CT scan finding	No(%)
Normal	239(51.9)
Rib Fracture	70(15.2)
Pneumothorax	59(12.8)
Subcutaneous Emphysema	80(17.4)
Hemothorax	(1.9)9
Lung Contusion	45(9.8)
Pneumothorax	(0.9)4
Atelectasis	44(9.5)
Pneumomediastinum	(1.3)6
Fracture of the scapula	13(2.7)
Fracture of the thoracic vertebra	34(7.4)
Sternal Fracture	(1.9)9
Clavicle Fracture	12(2.6)
Pneumopericardium	0(0)
Tamponade	2(0.43)

Table 2: prevalence of chest CT scan findings in multiple trauma patients

N=490	Normal	Rib Fracture	Pneumothorax	Subcutaneous Emphysema	Lung Contusion	Atelectasis	Thoracic Vertebra Fracture	Other Cases*	Total
Age									
<20 _ No (%)	51(44.7)	10(8)	11(9)	11(9)	10(8)	9(7)	2(1)	10(8)	114(100)
21 - 40_ No (%)	137(53)	15(5)	19(7)	32(12)	15(5)	16(6)	3(1)	20(7)	257(100)
40< _ No (%)	51(20)	45(17)	29(11)	37(14)	20(7)	19(7)	29(11)	25(9)	255(100)
Total_ No(%)	239(38.1)	70(11.2)	59(9.4)	80(12.7)	45(7.2)	44(7)	34(5.4)	55(8.8)	626**(100)

*Including hemothorax, pneumothorax, pneumomediastinum, scapula fracture, sternum fracture, clavicle fracture and tamponade
** Due to the fact that some findings were repeated in some people, therefore the final sample size is more than 460

(1.9%). Lung contusion was noted in 45 patients, accounting for 9.8% of cases. Pneumopericardium was rare, observed in only 4 patients (0.9%).

Atelectasis was identified in 44 patients, accounting for 9.5% of cases. Pneumomediastinum was present in 6 patients, representing 1.3% of the study population. Fractures of the scapula were observed in 13 patients (2.7%), while fractures of the thoracic vertebra were found in 34 patients (7.4%). Sternal fractures were detected in 9 patients (1.9%).

Clavicle fractures were noted in 12 patients, making up 2.6% of cases. Notably, there were no instances of pneumopericardium in the study population. Tamponade was very rare, occurring in only 2 patients (0.43%).

These findings highlight the diversity and prevalence of different injuries detected by chest CT scans in trauma patients. The data provides valuable insights into the most common injuries in this patient population, with normal findings being the most prevalent, followed by rib fractures, pneumothorax, and subcutaneous emphysema. The presence of more severe injuries, such as hemothorax and tamponade, although less common, underscores the importance of thorough imaging in trauma assessment.

Table 2 presents the distribution of various chest CT findings across different age groups. Normal findings are the most prevalent across all age groups, particularly in the 21–40 age group (53%). Rib fractures and pneumothorax are more commonly found in patients over 40 years old, occurring at rates of 17% and 11%, respectively. Subcutaneous emphysema is relatively common in all age groups but peaks in the >40 age group at 14%.

Lung contusion, atelectasis, and thoracic vertebra fractures are relatively evenly distributed across age groups but show a slight increase in older patients (>40 years). The “Other Cases” category also shows a higher prevalence in the older age group.

The overall percentages for each finding reflect the presence of multiple injuries in some patients, resulting in the total number of cases (626) exceeding the total number of patients (490). This detailed breakdown highlights the variations in injury types

Table 3: prevalence of chest CT scan findings in multiple trauma patients

N=490	Normal	Rib Fracture	Pneumothorax	Subcutaneous Emphysema	Lung Contusion	Atelectasis	Thoracic Vertebra Fracture	Other Cases*	Total
Gender									
Male_ No (%)	161(37.7)	46(10.7)	37(8.6)	53(12.4)	31(7.2)	30(7)	22(5.1)	35(8.2)	426(100)
Female_ No (%)	78(39)	24(12)	22(11)	27(13.5)	14(7)	14(7)	12(6)	20(10)	200(100)
Total_ No(%)	239(38.1)	70(11.2)	59(9.4)	80(12.7)	45(7.2)	44(7)	34(5.4)	55(8.8)	626**(100)

*Including hemothorax, pneumothorax, pneumomediastinum, scapula fracture, sternum fracture, clavicle fracture and tamponade
** Due to the fact that some findings were repeated in some people, therefore the final sample size is more than 460.

Table 4: prevalence of chest CT scan findings in multiple trauma patients

N=490	Normal	Rib Fracture	Pneumothorax	Subcutaneous Emphysema	Lung Contusion	Atelectasis	Thoracic Vertebra Fracture	Other Cases*	Total
Mechanism of Trauma									
Accident_ No (%)	214(39.8)	67(12.4)	30(5.5)	65(12.1)	39(7.2)	39(7.2)	31(5.7)	52(6.9)	537(100)
Assault and Stab Wounds_ No (%)	23(14.8)	2(3)	19(28.7)	10(15.1)	5(7.5)	4(6)	2(3)	1(1.5)	66(100)
Gunshot Wounds_ No (%)	2(8.6)	1(4.3)	10(43)	5(21.5)	1(4.3)	1(4.3)	1(4.3)	1(4.3)	23(100)
Total_ No(%)	239(38.1)	70(11.2)	59(9.4)	80(12.7)	45(7.2)	44(7)	34(5.4)	55(8.8)	626**(100)

*Including hemothorax, pneumothorax, pneumomediastinum, scapula fracture, sternum fracture, clavicle fracture and tamponade
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and their distribution across different age groups, providing insights into trauma-related chest injury patterns.

Table 3 presents a comprehensive breakdown of chest CT scan findings based on gender among trauma patients. The majority of both male and female patients had normal CT scan results, with 37.7% of males and 39% of females showing no abnormalities.

Rib fractures were slightly more common in females (12%) compared to males (10.7%). Pneumothorax was also more prevalent in females (11%) than in males (8.6%). Subcutaneous emphysema had a higher incidence in females (13.5%) compared to males (12.4%).

Lung contusion and atelectasis were similarly distributed between males and females, with lung contusion observed in 7.2% of males and 7% of females, and atelectasis in 7% of both males and females. Thoracic vertebra fractures were slightly more common in females (6%) compared to males (5.1%).

The "Other Cases" category, which includes various less common findings, was more prevalent in females (10%) than in males (8.2%).

The total number of instances of findings (626) exceeds the number of patients (490) due to the presence of multiple injuries in some individuals. This detailed gender-based analysis highlights the distribution of different types of chest injuries, providing valuable insights into trauma-related findings among male and female patients.

Table 4 presents a scientific analysis of chest CT scan findings based on different trauma mechanisms: accidents, assaults and stab wounds, and gunshot wounds..

- **Accidents**: The majority of normal CT findings (39.8%) and other specific injuries, such as rib fractures (12.4%), subcutaneous emphysema (12.1%), and lung contusions (7.2%), were associated with accidents. This suggests that accidents are the most common cause of trauma leading to chest CT scans.
- **Assault and Stab Wounds**: Notably, pneumothorax (28.7%) was significantly more frequent in patients with assault and stab wounds compared to other injury types, indicating a higher

likelihood of this specific injury in such trauma cases.

• **Gunshot Wounds**: Pneumothorax (43%) and subcutaneous emphysema (21.5%) were the most common findings among gunshot wound patients. This highlights the severe nature of gunshot injuries to the chest, often resulting in these specific conditions.

Overall, the majority of trauma cases leading to chest CT scans were due to accidents, which accounted for 537 instances (100% of accident cases). Assaults and stab wounds accounted for 66 instances (100% of such cases), while gunshot wounds accounted for 23 instances (100% of such cases). This comprehensive analysis underscores the importance of understanding the distribution of various chest injuries across different trauma mechanisms to better inform clinical assessment and treatment strategies.

Discussion

In the present study, chest CT scan findings from 460 multiple trauma patients admitted to the emergency department of Khatam-Al-Anbia Hospital in Zahedan in 2023 were examined. The study revealed that 52% of cases had normal chest findings. Among the abnormal cases, the most common findings were subcutaneous emphysema (17.4%), rib fractures (15.2%), and pneumothorax (12.8%). The least common finding was tamponade (0.43%), and no cases of pneumopericardium were observed.

Most injuries were attributed to traffic accidents (90.2%), consistent with studies by Pouraghaei Mahboob et al. in Tabriz in 2021 [32] and Çorbacıoğlu et al. in Turkey in 2015 [34]. Given that traffic accidents are the leading cause of trauma across all provinces of Iran [3, 6, 7, 31, 32)], rib fractures, lung hemorrhage, and pneumothorax are expected findings. In this province, where the majority of emergency visits result from accidents, subcutaneous emphysema, rib fractures, and lung hemorrhage due to the pressure from accidents are the most common findings.

The study showed that the most common clinical complaint was chest pain (36.5%), while the least common was decreased heart sounds (1.7%). This finding did not align with the study by Oikonomou et al. in Greece in 2011 (35), but it was consistent with the study by Safari et al. in Tehran in 2019 [33]. The discrepancy with some foreign studies may be due to differences in trauma mechanisms, sample sizes, and sample selection methods in emergency settings. Given the large sample size in this study, the data can be generalized to cases reported to the emergency department of Khatam-Al-Anbia Hospital in Zahedan.

According to the results of this study, CT scan findings did not significantly differ by gender but varied by age. Normal findings were more common in individuals under 20 years old, whereas rib and vertebral fractures were more prevalent in those over 40 years old. This result is consistent with the study by Rezaeinasab et al. in Rafsanjan in 2010 [45]. Younger individuals generally exhibit greater physical resilience compared to adults and the elderly, making them relatively less susceptible to injuries under similar conditions. Conversely, older adults are more vulnerable under the same circumstances. The nature of the trauma and its underlying cause may also influence these findings

The chi-square test showed a significant difference in CT scan findings based on trauma mechanism. Traffic accidents and collisions predominantly resulted in rib and vertebral fractures, while pneumothorax was most common in cases of assault. Additionally, CT scan findings varied significantly by clinical complaints. Pneumothorax and rib fractures were most frequently observed in patients with chest pain and deformity complaints. This result aligns with the study by Çorbacıoğlu et al. in Turkey in 2015 [34]. The mechanism and cause of trauma influence chest injuries and subsequent pain and deformity. The high rate of chest trauma due to traffic accidents, leading to rib fractures and pain, is particularly notable. In cases of assault, pneumothorax was the most common injury, likely due to the use of sharp or blunt objects targeting the chest.

The study by Pouraghaei Mahboob et al. in Tabriz in 2021 also found that traffic accidents were the most common cause of trauma. In nearly half of the patients, no abnormalities were observed on spiral chest CT scans. Multiple findings were present in 21 patients. The most common injuries were rib fractures (11.3%), pneumothorax (12.3%), pneumomediastinum (2%), hemothorax (4.6%), and lung contusion (4.9%). Among multiple trauma patients, rib fractures were the most prevalent CT findings, followed by pneumothorax, subcutaneous emphysema, and hemothorax. The study indicated that in cases involving fractures of the first three ribs or scapula and high-energy trauma, the incidence of intra-thoracic and abdominal organ injuries was higher. Chest CT is particularly effective in diagnosing minor hemothorax and pneumothorax, which may not be detectable with simple radiography [32].

The study by Safari et al. in Tehran in 2019 found that chest wall deformity, general tenderness, and decreased heart sounds were significant clinical predictors of abnormal chest CT findings. Based on the results, chest wall abnormalities, tenderness, decreased heart sounds, high-energy trauma mechanisms, male gender, respiratory rate over 20 breaths per minute, decreased lung sounds, and chest wall deformities were identified as independent

clinical predictors of abnormal chest CT findings following trauma [33].

The study by Anastasia Oikonomou et al. in Greece in 2011 indicated that chest injury is generally the third most common type of trauma after head and limb injuries. Chest trauma has high complication and mortality rates, accounting for approximately 25% of trauma-related deaths—second only to head injuries. More than 70% of chest traumas result from motor vehicle collisions, with the remainder due to falls or blunt force impacts. The mechanisms of injury and the spectrum of abnormalities observed in blunt chest trauma include pleural space injuries (pneumothorax, hemothorax), lung injuries (pulmonary contusion, laceration, and hernia), airway injuries (tracheobronchial tear), and injuries involving the esophagus, heart, aorta, diaphragm, and chest wall (rib, scapula, and sternum fractures, as well as sternoclavicular dislocations).

The simultaneous presence of multiple types of injuries in a single patient necessitates systematic exclusion through a thorough examination of all potential injury types. The superiority of CT over chest radiography in diagnosing chest trauma is well documented. Additionally, with the advent of MDCT, imaging time for trauma patients has significantly decreased to just a few seconds, allowing more time for appropriate post-diagnosis care. High-quality multi-slice and volume-rendered CT images significantly enhance injury diagnosis and improve the understanding of trauma-related abnormalities [35].

This study found that the most and least common vital signs were SpO_2 below 95% (41.7%) and a heart rate exceeding 100 beats per minute (2.7%), respectively. The chi-square test showed no significant difference in CT scan findings based on vital signs. This result is consistent with the study by Hassami et al. in Kermanshah in 2015 [44]. Given that most injuries involved the chest and the most common complaint was chest pain, the high incidence of complications such as hypoxia and decreased oxygen saturation is unsurprising. Therefore, monitoring blood oxygen saturation levels is crucial upon the arrival of these patients in the emergency department.

Overall, trauma is considered a societal epidemic. Despite its associated mortality and the billions of dollars in societal losses, it is sometimes overlooked. Clinically and socially, trauma and its timely diagnosis and complications should be critically examined in healthcare centers. This study revealed that trauma predominantly threatens the productive age group, with traffic accidents involving motor vehicles being the most common cause. These incidents primarily affect young and middle-aged individuals, making the high prevalence of trauma in this demographic expected. The resulting disabilities and fatalities impose significant burdens on society and the healthcare system. The findings of this study align with similar studies [23, 33, 34].

Other studies have cited the increasing number of motor vehicles, lack of safety measures, and rising speeds as potential factors contributing to the high incidence of vehicle-related trauma [11, 12]. It is recommended that regulations and infrastructure improvements be implemented to prevent such accidents and mitigate their consequences.

The findings also indicate that stab wounds and assaults are the second most common cause of trauma, though some studies report gunshot wounds as the second leading cause, while this study ranks them third. Nonetheless, interventions for injured individuals reveal visceral damage within the chest in certain cases. Chest trauma can result in hemothorax, respiratory insufficiency, cyanosis, confusion, bradycardia, or tachycardia. Additionally, tension pneumothorax, tracheal obstruction, and hypotension may occur, necessitating immediate intervention [45–47].

According to the present study and previous studies [32–34], non-penetrating chest trauma can lead to rib fractures and an increased risk of hemothorax, while multiple rib fractures may cause pulmonary contusion, which might not be detectable on initial chest radiography [15, 16]. It is important to note that upper rib fractures may indicate significant vascular injury and severe bleeding, whereas lower rib fractures may result in diaphragm rupture. Liver and spleen injuries due to trauma can lead to hemorrhage, while aortic rupture and cardiac tamponade can cause hypovolemic shock [45, 46].

It is suggested that appropriate care programs be developed and made available to various healthcare and emergency departments, with initial assessments based on the Airway, Breathing, Circulation, Disability, and Exposure (ABCDE) framework to identify life-threatening factors. Additionally, actions such as ultrasound and other diagnostic evaluations should be conducted to assess intra-abdominal organ damage that may lead to bleeding and shock [48, 49].

Ethics Approval

This study was approved by the Ethics Committee of Zahedan University of Medical Sciences (Approval Code: IR.ZAUMS.REC.1402.374).

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