



# Patterns of Chest Injuries among Yemeni Patients: a Retrospective Analysis

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## ABSTRACT

**Objective:** To investigate the patterns of thoracic injuries and the methods used for their management.

**Methods:** A retrospective descriptive analysis of 275 chest trauma cases managed at the University of Science and Technology Hospital over the period 2010–2013.

**Results:** Of 275 consecutive patients with chest trauma, 72.7% were males and 7.27% were females with a mean age of 33.6 years old. Blunt injuries represented 51% (125 males and 15 females) while penetrating injuries represented 49% (130 males and five females) of the cases. Among the penetrating injury group, three patients (1.1%) were with direct sustaining cardiac injuries. The most common presenting features associated with injuries were pain (100%), dyspnea (78.6%) and hemorrhagic shock (17%). Concurrent extrathoracic injuries were found in 22.2% (61/275) of the total chest injuries; spinal cord injuries (3.3%; 9/275), brain injuries (6.2%; 17/275) and intraperitoneal injuries (4.4%; 12/275) and bone fractures (7.3%; 23/275). The first three types of extrathoracic injuries were mostly due to penetrating injuries that necessitated a thoracoabdominal approach or chest tube drainage (CTD) and laparotomy. Computerized tomography scan, chest X-ray, ultrasound and echocardiography were the main diagnostic tools, being used for the diagnosis of 95.27%, 96.72%, 9.73% and 9.33% of cases, respectively. Intercostal tube thoracostomy was required for the management of 96.3% (130/135) of patients with penetrating injuries; early thoracotomy was performed in 25.9% (35/135) of patients to control over bleeding while late thoracotomy was performed in 16.3% (22/135) of patients for removal of retained foreign body and empyema. The CTD was performed in 76.4% (107/140) of patients with blunt injuries, whereas 23.6% (33/140) patients had conservative management and only 2.9% (4/140) of patients underwent thoracotomy. The average hospital length of stay was 6 days for penetrating trauma group and about 7 days for blunt trauma group. Out of all admitted cases, 94.5% (260/275) were cured while 5.5% (15/275) died. It is concluded that CTD is the most appropriate method of treating complicated chest injuries; however, the penetrating trauma has a higher rate of internal damage that requires early intervention to save life, especially for severe or progressive intrathoracic bleeding and cardiac injury. Pulmonary contusion and rib fracture were the most common complications of chest traumas, for which strong painkillers, anti-infective therapy, respiratory care measures and mechanical ventilation are the components of an effective treatment strategy. The associated extrathoracic injuries constitute a major prognostic factor in chest traumas, which were higher in blunt traumas.

**Keywords:** Chest injury, Chest tube drainage, Thoracotomy, Yemen

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## 1. Introduction

Trauma has increasingly become a major public health problem worldwide because it is associated with high morbidity and mortality in developed and developing countries (1). Cardiothoracic trauma occurs in about 60% of multi-trauma patients and is two to three times more common than intra-abdominal visceral injuries. It constitutes about 25% of traumatic deaths and contributes significantly to at least another 25% of these fatalities. Though only about 15% of chest traumas require operative interventions, a considerable number of preventable deaths occur due to an inadequate or delayed treatment of otherwise an easily remediable injury (2). Chest injuries are encountered in civilian and military practice worldwide. Injuries can be penetrating or blunt, depending on the nature and severity of the causative impact (3). Thoracic trauma may be associated with injuries to other organs, particularly in traffic accidents (4). While the majority of patients with thoracic trauma can be managed conservatively, a small but significant number requires emergency thoracotomy as part of their initial resuscitation (1). The present study was conducted in the University of Science and Technology Hospital (USTH) to describe its own experience in the management of chest injuries, outlining the patterns of these injuries and methods used for their management. The study presents the etiology, associated injuries, management and outcome of chest traumas in the local setting.

## 2. Methods

All chest injury patients of all age groups and both sexes who were managed surgically or conservatively after sustaining penetrating or blunt thoracic injuries at the USTH during the

study period (2010–2013). Retrospectively, patients' data were analyzed to determine the age profile, sex distribution, trauma type, etiology, concomitant injuries, hospital length of stay (LOS), management methods and outcome. Early thoracotomy was defined as a thoracotomy required for imminent surgical repair of the injuries in the operating theatre that allows the direct control of intrathoracic hemorrhage, evacuation of pericardial tamponade and control of massive air embolism. Delayed or late thoracotomy was defined as a procedure (>24 hours) for removing foreign bodies or for missed injuries and post-injury complications such as empyema or persistent air leak (5).

Injured patients were first triaged by a specialist in the Emergency Department (ED) and were then referred to a cardiothoracic surgeon if needed. Patients with hemodynamic instability or those with flail chest were admitted to the Intensive Care Unit (ICU), and mechanical ventilation was used for respiratory deficiency or severe brain trauma. Beyond resuscitation in emergency situations, specific treatment depends on the pathology detected. The primary purposes in the management of chest trauma were the prompt restoration of normal cardiopulmonary function, treatment of associated injuries and prevention of sepsis. The patients were then transferred to the operating theatre with a definite diagnosis of cardiothoracic trauma with massive hemothorax or tamponade by Computerized tomography (CT) scan and echocardiography.

## 3. Results

Over a three-year period, 275 patients with thoracic traumas (255 males and 20 females with a mean age of 33.6 years old) were referred to the ED with penetrating thoracic injuries; 49% of them presented with penetrating



chest trauma and 51% presented with blunt trauma. However, 25.5% of patients presented with both thoracic and abdominal traumas.

### 3.1. Penetrating injuries

The penetrating chest traumas represented 49% (135/275) of the total chest injuries, and gunshot was the main mechanism of injury (Figure 1). Among patients with penetrating chest trauma, three patients presented with cardiac and thoracic injuries. The most common presenting features are presented in Figure 2. The concurrent associated extrathoracic injuries accounted for 14.8% (20/135) of all penetrating traumas (Table 1). Rib fracture represented the most common complication of chest injuries (94.1%; 127/135) followed by lung contusion (92.6%; 125/135) and hemothorax 35.6% (48/135) (Table 2).

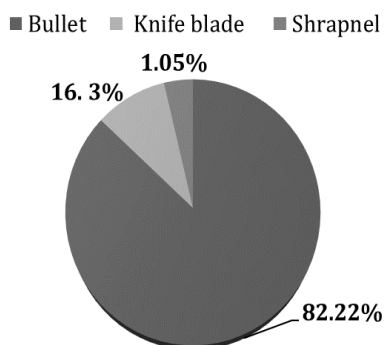


Figure 1. Causes of penetrating chest injuries

Overall, 96.3 % (130/135) of penetrating trauma patients were treated with tube thoracostomy while 3.7% (5/135) of patients were medically treated. Early thoracotomy for bleeding control was performed in 25.9% (35/135) of patients, whereas late thoracotomy for retained foreign body (bullet) removal and emphysema was performed in 16.3% (22/135).

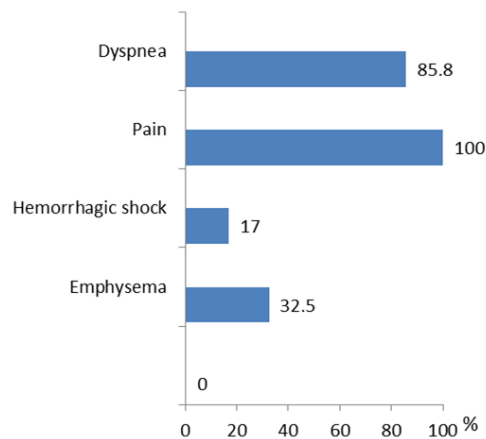


Figure 2. Most common presenting features of chest injuries

Table 1. Distribution of concurrent extrathoracic injuries and frequency of chest side injuries among Yemeni patients admitted to the USTH, Sana'a, Yemen in the period 2011–2013

Extrathoracic injury	Penetrating chest injury (n=135)	Blunt chest injury (n=140)	Total (n=275)	
	No. (%)	No. (%)	No. (%)	
Bone fractures	5 (3.7)	18 (12.9)	23 (8.4)	
Brain	0 (0.0)	17 (12.0)	17 (6.2)	
Intraperitoneal	10 (7.4)	2 (1.4)	12 (4.4)	
Spinal cord	5 (3.7)	4 (2.9)	9 (3.3)	
<b>Total</b>	<b>20 (14.8)</b>	<b>41 (29.3)</b>	<b>61 (22.2)</b>	
<b>The side</b>	<b>Left-sided</b>	77 (57.0)	75 (53.6)	152 (55.3)
	<b>Right-sided</b>	43 (31.9)	54 (32.1)	97 (35.3)
	<b>Bilateral</b>	15 (11.1)	11 (7.9)	26 (9.45)

Penetrating heart injuries occurred in 2.2% (3/135) of patients aged 24–30 years old, The mechanism of injury was gunshots in two cases and a knife-stabbing wound in the third case. The three patients with penetrating cardiac injuries were presented with shock and underwent urgent anterior thoracotomy. The time interval from wounding to arrival at the hospital was 1–3 hours. In the stabbing case, the injury was in the right ventricle while in one of the gunshot injuries; the bullet penetrated the right ventricle and moved backward through the right atrium and inferior vena cava to be impacted in the superior hepatic vein. The laceration of the right atrioventricular junction was found in one case. The range of LOS was 1–7



days in the ICU and 4–6 days in the ward of the hospital. Surgical repair with Teflon pledgets or pericardial strips were done without cardiopulmonary bypass. All penetrating heart injuries were managed successfully and fully recovered without complications with a one-year follow-up.

**Table 2.** Distribution of chest injuries among Yemeni patients admitted to the USTH, Sana'a, Yemen in the period 2011–2013

Type of injury	Penetrating (n=135)	Blunt (n=140)	Total (n= 275)	p-value
	No. (%)	No. (%)	No. (%)	
Hemothorax	48 (35.5)	60 (42.9)	108 (39.3)	0.216
Pneumothorax	37 (27.4)	29 (20.7)	66 (24.0)	0.194
Hemopneumothorax	45 (33.3)	18 (12.9)	63 (22.9)	<0.001
Cardiac injury	3 (2.2)	0 (0.0)	3 (1.2)	0.234
Lung contusion	125 (92.6)	140 (100.0)	265 (96.4)	0.003
Lung laceration	27 (20.0)	2 (1.4)	29 (10.2)	<0.001
Rib fracture	127 (94.1)	138 (98.6)	265 (96.4)	0.095
Clavicle fracture	2 (1.5)	52 (47.1)	54 (19.6)	<0.001
Scapula fracture	15 (11.0)	32 (22.9)	47 (17.1)	0.009
Flail chest	0 (0.0)	12 (8.6)	12 (4.3)	NA
Open sucking chest wound	3 (1.3)	0 (0.0)	3 (1.1)	NA
Mediastinal emphysema	9 (6.7)	7 (5.0)	16 (5.8)	0.555
Subcutaneous emphysema	18 (13.3)	37 (26.4)	55 (20.0)	0.007
Diaphragm rupture	2 (1.5)	1 (0.7)	3 (1.1)	0.975
Intercostal vessel injury	15 (11.0)	1 (0.7)	16 (5.8)	<0.001
Chest wall injury	23 (17.0)	0 (0.0)	23 (8.4)	NA
Mammary vessel injury	3 (1.3)	0 (0.0)	3 (1.1)	NA
Left main bronchus avulsion	0 (0.0)	1 (0.7)	1 (0.4)	NA
Chylothorax	1 (0.7)	0 (0.0)	1 (0.4)	NA

NA, not applicable

Complications were encountered in 5.9% (8/135) of cases, including empyema (3.7%; 5/135) and prolonged air leak (2.2%; 3/135). Hospital mortality because of trauma occurred in 2.9% (4/135) of penetrating injury cases, due to uncontrolled bleeding in three patients and to sepsis and multi-organ failure in the fourth patient.

### 3.2. Blunt Injuries

Patients with blunt chest traumas represented 51% (140/275) of chest injuries, which were mostly due to road traffic accidents (RTAs). RTAs were the most common cause of chest trauma rather than violence. In addition, there were unusual causes (Figure 2). The most common presenting features in both chest injury groups are shown in Figure 2. All cases with blunt injuries showed lung contusion. Table (1) shows the distribution of concurrent injuries, where the most common associated extrathoracic injury was bone fracture (8.4%; 23/275).

CTD was inserted in 107 (76.42%) patients of blunt injuries whereas 33 patients (23.57%) had conservative management and only 4 patients (2.85%) underwent thoracotomy for tracheobronchial repair and bleeding control. The morbidity rate among patients with blunt injuries was about 7% (10/140), where pneumonia and acute respiratory distress syndrome (ARDS) were the major complications in this group, being found in 5% and 2% of cases, respectively. Sepsis, ARDS and brain death were the main causes of the hospital non-operative mortality in the blunt injury group 11 (7.8 %) (Table 3).

### 3.3. Concurrent extrathoracic injuries

Concurrent extrathoracic associated injuries were found in 22.2% (61/275) of all chest injuries. Table (1) shows the distribution of concurrent extrathoracic injuries and the frequency of chest side injuries. CT scans, Chest X-ray (CXR), ultrasound (U/S), and echo were the main diagnostic tools, being used for the diagnosis of 95.3%, 96.7%, 9.7% and 9.3% of cases, respectively. The patients were then transferred to the operating theatre with a definite diagnosis of cardiothoracic trauma with massive hemothorax or tamponade by echo and CT scan. Two



patients with multiple traumas developed cardiac arrest, and surgery was then initiated after successful resuscitation under continuous volume restoration.

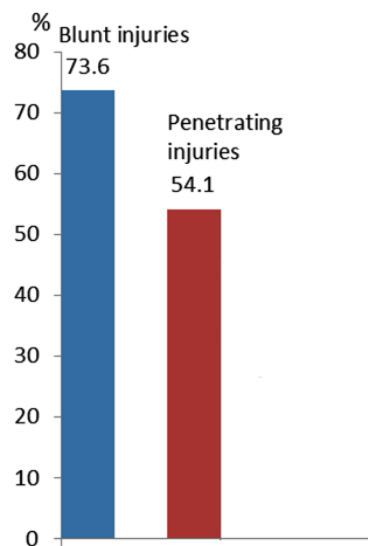
**Table 3.** Treatment of penetrating and blunt chest injuries among Yemeni patients admitted to the USTH, Sana'a, Yemen in the period 2011–2013

Treatment	Penetrating injury (n=135)	Blunt injury (n=140)	Total (n=275)
	No. (%)	No. (%)	No. (%)
Early thoracotomy	35 (25.9)	4 (2.9)	39 (14.2)
Late thoracotomy	22 (16.3)	0 (0.0)	22 (8.0)
Chest tube drainage	130 (96.2)	107 (76.4)	237 (86.2)
Conservative	5 (3.7)	33 (23.6)	38 (13.8)

With respect to the distribution and frequency of injuries, data of operative, clinical and radiological findings are shown in Table (2). Overall, lung contusion and rib fractures were the most frequent in both groups. Surgical interventions were indicated for 22.2% (61/275) of patients, including 39 early thoracotomies and 22 delayed thoracotomies. Among the early thoracotomies, 27 (9.8%) were performed for massive hemothorax, 4 (6.6%) for diaphragmatic rupture with concurrent intra-abdominal injuries, 3 (4.9%) for penetrating cardiac injuries and 4 (6.5%) for massive air leak.

The resuscitative measures and chest tube insertion (Figure 3) were curative in 64% (176/275) of all injured cases. Table (4) shows the operative rate and outcomes either as average hospital LOS or as mortality in both chest injury groups. Complications were equally present in both groups and found to be insignificantly associated with mortality. Regarding mortality, three cases died of massive uncontrolled hemorrhage before the performance of thoracoabdominal exposure, three of ARDS

while nine of severe multiple trauma patients due to brain death and multi-organ failure.



**Figure 3.** CTD as a curative measure for chest injuries

**Table 4.** The operative rates, outcomes and curative rates among Yemeni patients admitted to the USTH, Sana'a, Yemen in the period 2011–2013

	Penetrating (n=135)	Blunt (n=140)	Total n= 275	p-value
	No. (%)	No. (%)	No. (%)	
Operative management	57 (42.2)	4 (2.9)	61 (22.2)	<0.001
Average hospital stay	6 (4.4)	10 (7.1)	16 (5.8)	0.339
Morbidity	8 (5.9)	10 (7.1)	19 (6.9)	0.876
Operative mortality	4 (2.9)	1 (0.7)	5 (1.8)	0.345
Non-operative mortality	0 (0.0)	10 (4.3)	10 (3.6)	NA
Curative rate	131 (97.0)	129 (92.0)	260 (94.5)	0.074

NA, not applicable

## 4. Discussion

In this study, the mean age of injured patients was 33.6 years old. Males were more frequently affected than females due to their greater exposure to outdoor activities and propensity to violence. The male to female ratio of 13:1 among chest injuries in the present study is higher than the 5.5:1 ratio reported in a prospective analysis of 168 patients in Nigeria (6),



but is slightly lower than the 14.9:1 ratio reported in a Pakistani study of 191 penetrating injury cases (7).

The leading cause of chest injuries was the violence-related penetrating injuries (49%) followed by RTAs (46%). The high violence incidence could be due to the consecutive events of violence and the uncontrolled and non-ruled weapon carry and use. Yemeni citizens obtain firearms easily. Therefore, the majority of penetrating chest injuries were due to gunshot wounds, representing 111 82.2% (111/135) of cases, which is slightly higher than the 72.2% (136/191) reported from Pakistan (7).

In this study, RTAs were the most common cause of blunt chest injuries rather than violence, which is comparable to those reported from Bugando, Tanzania (8) but higher than those reported from Damascus, Syria (9). Activating the traffic laws, including seat belt enforcement, and ensuring road safety measures are required to reduce the incidence and severity of chest injuries in Yemen. Unusual causes of chest injuries included animal violence (cow butting) or wall fall-out. Concurrent injuries were found to be more prominent among the dead, which is similar to a previous finding among Nigerian patients (10).

Of both types of the studied injuries, the majority of patients (57%; 77/275) had left-sided penetrating injury followed by those with right-sided penetrating injury (31.8%; 43/275) while bilateral injury (either side-to-side injury or concurrent both sides) was found in 11% (15/275) of cases. The finding of the present study is consistent with that by Yazici et al. (11) who reported that the left-sided outnumbered right-sided injuries with a margin of 1.8:1.

Several chest injuries were detected pre-operatively or discovered by surgical exploration such as pulmonary contusion, which was the most common complication identified in 96.4% of patients and for which strong anti-infective therapy, painkiller, respiratory care measures and mechanical ventilation were the effective treatment strategy. Thoracic CT is more likely to detect contusions than the CXR and gives more accurate diagnosis and differentiation from other clinical entities such as atelectasis (13). It is the main diagnostic modality in our practice, thus a high rate of pulmonary contusions was reported. Rib fractures occurred in 94% of the penetrating injury patients and in 98% of blunt injury patients in the present study. This can be explained by the fact that the true incidence of bony thoracic injury may be under-reported, as up to 50% of fractures may be undetected radiographically (12) because CXR is routinely used to assist in the diagnosis of rib fractures, even though it has limited sensitivity (13).

Associated extrathoracic injuries were observed in 22.2% of admitted cases, which is lower than the rates reported in the literature (9, 18). The most common extrathoracic penetrating injuries were intraperitoneal injuries, which were found in 4.4% of penetrating injuries and necessitated the thoracoabdominal approach or CTD and laparotomy

The literature supports the continued use of CXR for initial screening of patients who have sustained blunt chest traumas. In the appropriate clinical setting and with a CXR demonstrating mediastinal widening or other signs of mediastinal hemorrhage, chest CT angiography is emerging as a very sensitive and specific examination for aortic injury. The CXR and CT scans are complementary examinations (14), both of which were performed in most of our cases



while the U/S and echo were suitable for bedside use.

Generally, most victims of heart injuries die at the scene of accident, even patients who arrive at hospital alive have high mortality rate (10–50%) (15). However, good results can be achieved by immediate diagnosis and aggressive treatment (19). The three cases of cardiac injury in the present study were operated successfully and fully recovered without complications with a one-year follow-up.

Primary purposes of the management of chest injuries are the prompt restoration of normal cardiopulmonary function, control of bleeding, treatment of associated injuries and prevention of sepsis. In the present study, the management modalities correlate with those reported in the literature (16, 17). Most penetrating chest injuries do not require major operative interventions, and several patients are managed with observation and serial evaluation using radiography or simple tube thoracostomy (11). Tube thoracostomy was the choice of treatment in chest injury complicated with rib fractures and hemopneumothorax. In the present study, tube thoracostomy was performed in the majority (86%) of patients; in 96.3% of patients with penetrating injuries and in 76 % of patients with blunt injuries. This is higher than those performed in Pakistan (7), which could be attributed to the higher usage of CTD in the diagnostic and therapeutic measures in the pre-hospital care.

Thoracic surgeons (3, 6) generally agree that most patients with penetrating chest injuries could be managed adequately by closed thoracostomy tube drainage alone. Demirhan et al. (18) reported 46% tube thoracostomy with favorable outcomes. In this study, resuscitative measures and chest tube insertion were cura-

tive in 64 % of cases. However, 22% of patients with chest tube drainage underwent an early exploration or late thoracotomy during the follow-up period.

Gunshot wounds represent the major penetrating mechanism of injury for patients requiring thoracotomy, ranging from 13% to 70% of the cases (9, 16, 17), as opposed to less than 10% of injuries from blunt chest trauma. On the other hand, the present study found that early thoracotomy was performed in 26.0% of penetrating injuries and in 2.8% of blunt injuries. This practice is higher than those reported in the literature (9, 18). It was observed that severe chest trauma caused by high-velocity gunshot or RTA was associated with a high rate of pulmonary injuries necessitating CTD or intervention.

The treatment for injuries of the bony thorax has varied over the years, ranging from various forms of mechanical stabilization to obligatory ventilatory support. It is now generally recognized that pain control, chest physiotherapy and mobilization are the preferred modes of management for blunt chest trauma. In the present study, bronchial rupture was confirmed in one case which had a blunt injury, for whom primary repair through thoracotomy was successful.

The estimated mortality for penetrating chest trauma patients is also very variable. The overall mortality rate reported in the literature for patients with traumatic pulmonary injuries ranges from 1.7% to 37% (8). In the present study, the overall mortality rate was 5.4% (15/275), 7.9% (11/140) in the blunt injury group and 3.0 % (4/135) in the penetrating injury group. In Syria, the mortality rate was relatively lower (9), which may be attributed to high pre-hospital mortality rate. The outcome



of chest trauma depends on early diagnosis, multidisciplinary approach and urgent institution of care (18).

The contributory effect of associated injuries on mortality due to blunt chest trauma was clearly established in the present study, where the mortality rate was higher among patients with associated injuries, especially brain, spinal cord and intraperitoneal injuries. This was significant in blunt injuries and in non-operative patients. The results of the present study show that the associated extrathoracic injuries constitute a major prognostic factor in the chest injuries, as previously reported (4, 7, 10, 18). Thus, the cause of injury (penetrating vs. blunt) significantly affected the outcome of chest injury patients in terms of overall hospital LOS (4.4 vs. 7.3 days) or mortality (2.9% vs. 7.8%).

Based on the findings of the present study, it is recommended to follow recommendations set by other authors (3, 18) to significantly reduce the morbidity and mortality from chest injuries. Firstly, the incidence of blunt chest injuries could be reduced if measures are taken to reduce the number of RTAs and to improve ambulance services, educate the public and to establishing trauma centers. Secondly, the tribal disputes, armed conflicts, the political events, the low level of the strict judicial and security procedures that have been linked to a high incidence of violence chest trauma in other communities (6, 7, 11, 16) are similar to those in our country. Therefore, violent activities and social problems should be solved.

## 5. Conclusions

Penetrating chest injuries cause a high rate of internal damage that requires early intervention to save life, especially for severe or progressive intrathoracic bleeding and cardiac in-

jury. The CTD is the most appropriate method of treating complicated chest injuries. Pulmonary contusion and rib fracture are the most common complications in chest trauma, for which strong painkillers, anti-infective therapy, respiratory care measures and mechanical ventilation are the effective treatment strategy components. The associated extrathoracic injuries constitute a major prognostic factor in among Yemeni people with chest injuries, with a higher rate of blunt chest injuries.

## Competing interests

The author declares that he has no competing interests associated with this article.

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