



Thoracic Trauma: Analysis of 440 Cases

Toraks Travması: 440 Olgunun Değerlendirilmesi

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ABSTRACT

Aim: Trauma still has a significant place among the reasons for death before the age of 40. This study analyzed the cases with thoracic trauma that were monitored at our center in a period of eight years.

Material and Method: The study was conducted with 440 patients over the age of 16 (385 male, 55 female, mean age of 43.2 with a range of 17-89) who were treated at our center due to thoracic trauma in the period of 2011-2017. The patients were examined in terms of their age, sex, trauma etiology, clinical signs, accompanying injuries, surgery indications, applied surgical interventions, complications that occurred and mortality.

Results: Three hundred and eighty five (87.5%) of our cases were male, 55 (12.5%) were female, and their mean age was 43.7 (17-89). While 202 (58.6%) of our cases with blunt thoracic trauma had isolated trauma, 143 (41.4%) had multiple traumas. 88 (92.6%) of our cases with penetrating thoracic trauma had isolated trauma, whereas there were multiple injuries in seven (7.4%). The reasons for blunt thoracic traumas were motor vehicle accidents, falling from a height, battery and injuries caused by cattle. Penetrating thoracic traumas were caused by firearms and injuries by sharp and pointed objects. Single and multiple rib fractures were the most frequent among bone structure injuries in the thorax. Pneumothorax had the first place among intrathoracic injuries. The most frequently applied surgical method for treatment was tube thoracostomy, while sternotomy was the least frequently applied method.

Conclusion: The most significant accompanying problem that increases mortality in thoracic traumas are organ injuries. A patient with trauma should be systematically examined very fast, and unnecessary tests should be avoided.

Key words: surgery; thorax; trauma

ÖZET

Amaç: Günümüzde halen 40 yaş altı ölüm nedenleri arasında travma önemli bir yer tutmaktadır. Bu çalışmada sekiz yıllık süre içerisinde merkezimizde izlenen toraks travmalı olgular değerlendirildi.

Materyal ve Metot: Çalışmaya 2011-2017 tarihleri arasında toraks travması nedeniyle merkezimizde tedavi edilen 16 yaş üzerindeki 440 hasta (385 erkek, 55 kadın; ortalama yaş 43.2 dağılım 17-89) alındı. Hastalar yaş, cinsiyet, travma etyolojisi, klinik bulgular, eşlik eden yaralanmalar, ameliyat endikasyonları, uygulanan cerrahi girişimler, gelişen komplikasyonlar ve mortalite açısından incelendi.

Bulgular: Olgularımızın 385'i (%87.5) erkek, 55'i (%12.5) kadın olup, yaş ortalaması 43.2 (17-89) yıl idi. Künt toraks travmalı olgularımızın 202'si (%58.6) izole travma iken, 143'ü (%41.4) multipl travmaydı. Penetran toraks travmalı olgularımızın 88'i (%92.6) izole toraks travması iken, yedi (%7.4) olguda ise multipl yaralanma mevcuttu. Künt toraks travmalarının nedenleri motorlu araç kazaları, yüksekten düşme, darp, büyük baş hayvanların sebep olduğu yaralanmalar idi. Penetran toraks travmalarını ise ateşli silah yaralanması ve delici kesici alet yaralanması oluşturmuyordu. Toraksın kemik yapı yaralanmalarında en çok tek veya çoklu kosta kırığı tespit edildi. İntratoraksik yaralanmalarda ise pnömotoraks ilk sırayı alıyordu. Tedavide en fazla uygulanan cerrahi yöntem tüp torakostomi iken en az uygulanan yöntem ise sternotomi idi.

Sonuç: Toraks travmalarında mortaliteyi artıran en önemli neden eşlik eden organ yaralanmalarıdır. Travmalı bir hasta hızlı bir şekilde sistematik olarak değerlendirilmeli ve gereksiz tetkiklerden kaçınılmalıdır.

Anahtar kelimeler: cerrahi; toraks; travma

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Introduction

Trauma still has a significant place among the reasons for death before the age of 40. About 20–25% of trauma-related deaths in the first four decades of life are caused by thoracic trauma (TT)¹. It is in the third place following cardiovascular diseases and cancer among the reasons of death in all age groups². Considering the frequency of trauma, TT has the third place following head and extremity traumas³. The mortality rate in patients with penetrating injuries among TT patients is lower. While the mortality rate in cases of sharp and pointed object injuries is 1–8%, it is 14–20% in cases of firearm injuries. Where there is injury of the diaphragm, major veins and the lungs in TT, mortality is in the range of 25–28%⁴. The frequently encountered reasons for TT include motor vehicle accidents, firearm injuries, falling from a height, battery and incidents caused by cattle.

In this study, the records of cases that were treated as inpatients at our clinic for TT were retrospectively scanned. The patients were examined in terms of their age, sex, trauma etiology, clinical signs, accompanying injuries, surgery indications, applied surgical interventions, complications that occurred and mortality in the light of the literature.

Material and Method

The files of 440 cases that were treated as inpatients at our hospital between January 2011 and December 2017 were retrospectively examined. The cases were investigated in terms of age, sex, trauma etiology, clinical signs, accompanying injuries, surgery indications, applied surgical interventions, complications that occurred and mortality. Intravehicular and extravehicular traffic accidents, thoracic traumas caused by cattle and all kinds of falling and battery were included as the reasons for blunt TT, while sharp-pointed object injuries and firearm injuries were included as the reasons for penetrating TT.

Posteroanterior (PA) lung radiography was taken routinely for all cases with TT. In cases with multiple traumas, thoracic computerized tomography (CT), cranial CT, neck CT and abdominal ultrasonography (USG) were requested. Additional tests of doppler USG and echocardiography were applied to patients who were considered for potential peripheral vascular pathology and cardiac pathology respectively. As laboratory tests, complete blood and biochemistry tests were run routinely for all the cases, while in some cases based on the

type of injury, additional urine and blood tests were run. Tube thoracoscopy, video-assisted thoracoscopy, thoracotomy and sternotomy were separately noted as surgical treatments. The cases that were not surgically operated were clinically monitored with daily (PA) lung radiographies. Medical treatments included oxygen inhalation, analgesics, intercostal nerve block and respiration physiotherapy.

Results

Three hundred and eighty five (87.5%) of our cases were male, 55 (12.5%) were female, and their mean age was 43.7 (17–89). 345 (78.4%) were treated as inpatients due to blunt TT and 95 (21.6%) were treated likewise due to penetrating TT. While 202 (58.6%) of our cases with blunt thoracic trauma had isolated trauma, 143 (41.4%) had multiple traumas. 88 (92.6%) of our cases with penetrating thoracic trauma had isolated trauma, whereas there were multiple injuries in seven (7.4%). While the most frequent reason for blunt TT cases was motor vehicle accidents (n=120, 45.3%), the most frequent reason for penetrating TT cases was firearm injuries (n=50, 52.6%) (Table 1).

Among all cases, 342 (77.7%) had isolated and 98 (22.3%) had multiple TT. There were multiple injuries in 143 cases with blunt TT. These were head trauma (n=65, 45.5%), extremity injuries (n=55, 38.5%), abdominal injuries (n=15, 10.5%), neurovascular injuries (n=8, 5.5%). The reasons for abdominal injuries were diaphragm perforation in four cases, liver laceration in five cases and spleen injury in six cases. Diaphragm ruptures and liver lacerations were primarily closed. While two cases with spleen injury were conservatively monitored, splenectomy was applied on the other four. Neurovascular injuries included two (25%) in the brachial artery, one 12.5%) in

Table 1. Distribution of thoracic traumas based on etiology

		n (%)
Blunt thoracic traumas	Motor vehicle accidents	164 (47.5)
	Falling from height	97 (28.2)
	Battery	46 (13.3)
	Injuries caused by cattle	38 (11.0)
	Total	345 (100)
Penetrating thoracic traumas	Firearm injuries	50 (52.6)
	Sharp-pointed object injuries	45 (47.4)
	Total	95 (100)

the aorta on the arcus level, three (37.5%) in the ulnar artery and two (25%) in the ulnar nerve. The patient with partial rupture of the arcus aorta on the level of the ligamentum arteriosum as a result of blunt trauma was given left thoracotomy and the artery was primarily closed. This patient died two days after the surgery in the intensive care unit. Primary closure was applied in other artery injuries. Ulnar nerve injury was in the form of neuropraxia in all cases and it was left to spontaneous recovery. There were additional injuries in seven cases (7.3%) with penetrating TT. Among these patients, three had liver injury, two had spleen injury and one had radial artery injury. Radial artery injury was primarily closed. A case with diaphragm injury was thoroscopically treated. While primary closure was made in a case with liver injury, the other two were monitored without surgery. Two cases with spleen injury were conservatively monitored without surgery. In 313 patients with blunt TT and 27 patients with penetrating TT had bone fractures. Concerning thoracic injuries, there was no significant difference between the trauma types (Chi-Square=5.296; p=0.456). However, the difference regarding intrathoracic injuries was significant; there were no cardiac injuries with blunt trauma (Chi-Square=21.660; p<0.001) (Table 2). The total number of blunt TT in Table 2 is more than 385 blunt TT. The reason for this is that some patients have multiple injuries. The total number of patients with penetrating TT is 80 in the same table. The total number of penetrating TT cases was 95. The reason for the difference between the 15 patients was the thoracic bone structure and the extrathoracic injury (skin, subcutaneous and muscle tissue) which did not cause intrathoracic injury.

The etiology of 38 patients with blunt TT was based on cattle. While there were rib fractures in most of the cases, there was liver laceration in one case, spleen laceration in two cases and vertebral fracture in one. All cases with blunt TT were given rest and analgesics support during their treatment. Ventilator support was needed in eighteen cases with blunt TT. The patients were surgically operated by tube thoracostomy, video thoracoscopy, thoracotomy and sternotomy. There was a significant difference between the groups concerning treatment types (Chi-Square=39.126; p<0.001); Intercostal blockage and ventilator treatment were not applied to penetrating injuries (Table 3). Intervention was made on the cases with multiple traumas that were admitted to the emergency service by the relevant departments, and treatment was provided. There was no intraoperative or postoperative death among the

patients that were being monitored in the thoracic surgery clinic. Nine patients, who were hospitalized in the other departments due to their primary pathologies whose treatment included the thoracic surgery department because of their thoracic trauma, lost their lives. The cause of death was acute respiratory distress syndrome in four cases, sepsis in two, intracerebral hemorrhage in two and brain death due to multiple organ deficiency in one.

Table 2. Thoracic bone structure and intrathoracic injuries

Sign	Trauma type		Chi-Square	p*
	Blunt n (%)	Penetrating n (%)		
Thoracic bone structure injuries				
Single or multiple rib fracture	261 (83.4)	27 (100)	5.296	0.456
Clavicle fracture	22 (7.0)	0		
Flail chest	16 (5.1)	0		
Sternum fracture	9 (2.97)	0		
Scapula fracture	5 (1.6)	0		
Total	313 (100)	27 (100)		
Intrathoracic Injuries				
Pneumothorax	85 (33.8)	18 (34.0)	21.660	0.006
Hemopneumothorax	69 (27.4)	14 (26.4)		
Lung contusion	64 (25.3)	6 (18.8)		
Subcutaneous emphysema	28 (11.1)	10 (22.6)		
Diaphragm injuries	4 (1.6)	2 (3.7)		
Cardiac injuries-	0	3 (5.6)		
Tracheobronchial injuries	1 (0.4)	0		
Lung hernia	1 (0.4)	0		
Total	252 (100)	53 (100)		

* Fisher's exact test.

Table 3. Treatment approaches

Treatment	Type of trauma		Chi-Square	P*
	Blunt n (%)	Penetrating n (%)		
Resting	345 (100)	95 (100)	39.126	<0.001
Analgesics	345 (100)	95 (100)		
Intercostal blockage	42 (12.1)	0		
Respiratory physiotherapy	325 (94.2)	75 (78.9)		
Ventilator	26 (7.5)	0		
Tube thoracostomy	225 (65.2)	82 (86.3)		
Video-assisted thoracoscopy	5 (1.4)	3 (3.1)		
Thoracotomy	6 (1.7)	7 (7.3)		
Sternotomy	2 (0.5)	3 (3.1)		

* Fisher's exact test, Monte Carlo approach.

Discussion

Thoracic trauma has a wide variety from a simple soft tissue injury to thoracic injuries that threaten life. Thoracic trauma is the third most frequently seen type of trauma in multiple trauma patients after head and extremity traumas⁵. In TT, there is a risk of damage in the lungs, the heart and major arteries. Injury in these organs threatens life and leads to morbidity and mortality by disrupting perfusion and oxygenation. The average age of adults who experience TT in Turkey varies in the range of 38–43 years⁶. In our study, the mean age of the cases was 43.2. Blunt TT usually occurs in injuries caused by motor vehicle accidents, falling, battery or injuries caused by cattle⁷. The cause that was most frequently encountered in our study was motor vehicle accidents in blunt TT and sharp-pointed object injuries in penetrating TT. This distribution was in agreement with the literature^{2,7}.

PA lung radiography is the first method of imaging used in assessing the severity of trauma, making decisions for surgery and usage of advanced imaging techniques in patients with TT⁸. CT is used as a more detailed imaging method in multiple injuries and possible thoracic trauma.

All bone structures forming the thoracic wall may be affected by trauma. The most frequently encountered injury in thoracic traumas is rib fractures⁹. Rib fractures were seen in 261 (83.4%) cases in our study. While they were fewer than rib fractures, there were also clavicle, scapula and sternum fractures in order of incidence.

Flail chest is defined as the fracture of two or more places on three or more successive ribs. Separation of the cartilage parts that result in costochondral separation from the rib bone may also lead to flail chest¹⁰. The diagnosis of flail chest that is seen in 5–13% of all TT patients is made by physical examination. Ventilation becomes insufficient due to this issue¹¹. A large proportion of this is caused by motor vehicle accidents. In our study, there was incidence of flail chest in 16 cases (5.1%). Eleven of these were in a motor vehicle accident, four fell from a height and one had injury caused by cattle. In addition to open reduction and fixation techniques in treatment of flail chest, internal fixation with mechanical ventilators is also a method that may be preferred. While indications for costa stabilization in patients with a diagnosis of flail chest still do not have a sufficient amount of evidence, it is applied in less than 1% of patients¹². In our study, we chose the technique of open reduction and surgical fixation in cases of thoracotomy due to

other reasons such as hemothorax and lung parenchyma injury. In four cases, due to hemothorax that occurred secondarily to lung parenchyma injury, the ribs were fixed by steel wires after thoracotomy. Internal fixation was applied by mechanical ventilation in two cases. In the remaining cases, coordination was made with the pulmonary diseases department, and respiratory physiotherapy, pain management, and in some cases to clean secretions, fiberoptic bronchoscopy were applied.

Sternum fracture is seen in rates of 3–8% in blunt TT cases. It is frequently found in the upper and middle 1/3 of the bone^{13,14}. In our study, we found this in 9 (2.9%) cases. Motor vehicle accidents are found in the etiology of almost all sternum fracture cases. It was reported that fracture incidence has increased in recent years especially by obligation of wearing seatbelts^{14,15}. If there is no open fracture or excessively separated fracture, 2–3 weeks of resting by lying back with pain and secretion management is adequate for treatment. While the sternum was stabilized with steel wires in two cases with displaced sternum fractures in our study, the fractures that were not displaced were treated conservatively.

Myocardial contusion may lead to severe arrhythmia that threatens life. The possibility of myocardial damage should always be considered in cases with history of sternal region blunt trauma, cardiac monitorization, ECG follow-ups, cardiac enzyme and protein (CK, CK-MB and troponin I) monitoring should be carried out at the 12th and 24th hours¹⁶. Arrhythmia was detected in ECG in six of the cases with sternum fracture, and the CK-MB enzyme levels were high in four of these cases. When these cases were examined by echocardiography (ECHO), minimal pericardial effusion was found in three cases. The cases were closely followed up by cardiac monitorization, and no serious complication was observed.

In cases where there is a fracture of the clavicle, first and second ribs, examination should be made for possibility of subclavian artery and vein damage. The brachial plexus may also be damaged in such cases. These complications were not seen in any of our cases. In order to assess abdominal organ damage especially in fractures of the sixth and distal ribs, abdominal ultrasonography (USG) was used. Abdominal USG was used in a total of 20 cases with blunt and penetrating injuries. Among the cases with blunt TT, there was liver injury in three and spleen injury in two cases. While primary closure was used in liver injuries, splenectomy was used to treat the cases with spleen injury. Among the cases with penetrating TT, there was liver injury in three and spleen injury

in two cases. While primary closure was used in liver injuries, spleen injury was in the form of subcapsular hematoma and it was monitored. The area of hematoma did not expand and there was no reduction in the hemoglobin levels in the follow-ups. Multisystem injuries take place in a considerable part of TT cases, and interventions at the emergency services affect the morbidity and mortality in patients. Isolated thoracic trauma was reported in 17.7–77.3% of TT patients that were admitted to emergency services in Turkey¹⁷. This ratio was found to be 70.4% in our study.

Workplace accidents were the cause in 18 (18.5%) of the 97 cases who were exposed to trauma due to falling from a height. This corresponded to 4.0% of all the cases. Lung hernia secondary to costa fracture was observed in one case who arrived due to a workplace accident, and this was fixed with thoracotomy.

In our study, there were firearm injuries in 50 cases. Thirty two of these were shot by pistols, while 18 were shot by hunting rifles. There was lung parenchyma and thoracic wall injury in one of the cases who was shot by a pistol. The PA lung radiography showed pleural effusion. After detecting hemothorax as a result of thoracentesis, tube thoracostomy was applied under emergency conditions. As a result of thoracostomy, there was an initial drainage of 750 cc. After an additional drainage of 800 cc from the tube thoracostomy during clinical monitoring, the patient was taken into surgery in emergency conditions. It was found that there was a rupture of the parenchyma and intercostal vascular structures were damaged in the exploration of the patient who was given thoracotomy. The parenchyma was repaired, and the veins were ligated. Tube thoracostomy was sufficient in the treatment of other cases. There was diaphragm injury in one of the cases who were exposed to sharp-pointed object injuries, and this was thoracoscopically and primarily closed. After reaching the diagnosis of left hemothorax in one case as a result of being stabbed from the left parasternal region, emergency thoracotomy was applied. It was seen that the left internal thoracic artery (ITA) of the case was cut, and the cut ends of the artery were ligated. Twelve (26.6%) cases with minimal penetration to the thorax were closely monitored as their hemodynamics were stable. No surgical operation was made on these cases, and they were discharged with full recovery.

The clinical signs that are frequently encountered in cases of TT are pneumothorax, hemothorax, hemo-pneumothorax, pulmonary contusion and costa fracture. Pneumothorax was the most frequently observed

intrathoracic injury in our study. It was the case in 85 (25.7%) of the 252 cases with intrathoracic injuries. Rib fracture rates in blunt TT were reported to be in the range of 29–75%¹⁸. In our study, 261 (75.6%) of the TT cases had fractured ribs. As a result of laceration in the lung parenchyma secondary to pulmonary contusion trauma, blood and plasma flow into alveoli. Perfusion without ventilation leads to reduction in gas exchange. Pulmonary contusion is found in 17–70% of major injuries¹⁹. This ratio was found as 16.1% in our study. While it may be found in both blunt and penetrating injuries, it is seen more frequently especially in intravehicular traffic accidents as a result of hitting the chest to the steering wheel or other hard objects. It may also be seen in cases of falling from a height, injuries in the form of a blast and high-speed bullets.

Diaphragm injuries are not very prevalent. Laparoscopy and thoracoscopy are very successful methods for determining diaphragm injuries. These are seen by 5% in thoracoabdominal traumas²⁰. In our study, this rate was found as 1.4%.

In the literature, the rate of tracheobronchial injury as a result of blunt or penetrating trauma was reported as 0.5–2%²¹. This was reported in the range of 0.3–1.1% in publications made in Turkey¹⁷. We observed bronchial injury in 1 (0.2%) case. There was a partial rupture in the right main bronchus caused by blunt TT. Primary bronchial repair was provided to the patient by right posterolateral thoracotomy.

The literature in Turkish reported heart injuries to be in the range of 0.4–6% as a result of blunt or penetrating TT¹⁷. In our study, there were 3 (0.6%) cases with heart injuries. There was an injury in the right atrium in two cases and in the right ventricle in one case due to penetrating TT. While primary suturing was used in the case with right ventricular injury, primary closure was applied on the cases with right atrium injuries by sternotomy.

The surgical rates of thoracic traumas in the literature vary in the range of 2.9–8.4%^{3–22}. Indications for thoracotomy: cardiac injury or major vascular injury; serious and persistent hypotension that does not improve despite the intervention; at the time of hemorrhagic drainage tube thoracostomy 1500 be at least 200 ml in ml or around 3–4 hours; airway damage detected by pericardial tamponade; in the chest radiograph, one side hemothorax appears completely opaque; increased or non-evacuated hemothorax; trachea, bronchial or diffuse

parenchymal laceration and continued (>7 days) massive air leakage despite tube thoracostomy. In our study, surgery rate was found as 5.9, and this was in agreement with the literature.

The age, accompanying injuries and blunt injuries are the most important factors in predicting mortality in thoracic traumas. In blunt TT, it is crucial to detect the accompanying injuries and determine priority of treatment²³. In 75% of cases with thoracic trauma, other parts of the body are injured in addition to the thorax injuries³. Extremity, head, long bone and vertebral fractures, and abdominal injury were accompanying in most of the patients. These associated injuries affect mortality and morbidity to an important extent. In addition to hypoxia, hypercapnia and hypotension, thoracic traumas have negative effects on increased intracranial pressure in brain injuries by cerebral venous congestion developing due to decreasing venous return²⁴. In our study, the cause of death was acute respiratory distress syndrome in four cases, sepsis in two, intracerebral hemorrhage in two and brain death due to multiple organ deficiency in one.

In patients with thoracic trauma, the most important factors affecting the length of hospital stay are the patient's age, multi organ injury, accompanying complications and trauma type. In a study, the mean length of hospital stay was 8.02 days in patients who underwent penetrating TT and the mean duration of hospital stay was 5.94 days in blunt TT²⁵.

Consequently, most of those who visited our emergency service due to TT were male patients and those who were subjected to blunt trauma. Because of accompanying extrathoracic injuries and vital organ injuries, cases should be examined fast and systematically, and the necessary treatments should be provided immediately.

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