Annals of Clinical and Analytical Medicine
Original Research

Our initial evaluation and clinical approaches in penetrating thoracic traumas

Penetratıng thoracıc traumas

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Abstract

Aim: In this study, we aimed to explain the etiology of penetrating chest injuries, demographic characteristics of the injured, accompanying organ injuries, treatment, length of hospital stay, intensive care and blood replacement requirements, mortality and morbidity.

Material and Methods: The data of 130 patients over 18 years who applied to our institution with penetrating thoracic trauma were analyzed retrospectively. The age, gender, injury mechanism and instruments, localization of injury, affected organs, first and second interventions, length of stay, and the requirement for intensive care and blood transfusion were obtained from the hospital's electronic database. Additionally, complications and mortality rates were recorded.

Results: In cases with a gunshot injury, thoracotomy was the first intervention, and this was statistically significant compared to the intervention in ordinary cut injuries ($p<0.05$). Pneumothorax, hemothorax, contusion, pulmonary laceration, diaphragm, liver, and spleen wounds were significantly higher in intensive care patients. Pneumothorax, hemothorax, contusion, pulmonary laceration, pneumo-mediastinum, localization of diaphragm, liver, spleen, colon, and gastric wounds were significantly higher in individuals with a hospital stay of ≥7.

Discussion: In our, the average age and gender distribution were similar to the literature. The most common injury mechanism in our study was incision wounds. Our study is similar to the literature in this respect. Our pneumothorax rates were quite high compared to previous literature. This may be attributed to the involvement of iatrogenic injuries. In our study, it was observed that all iatrogenic injuries resulted in pneumothorax. Our tube thoracostomy rates are quite high compared to the conservative treatment approach. The low rate of conservative approach in cases brought by penetrating trauma has been one of the factors contributing to survival.

Keywords

Penetrating Thoracic Trauma, Thorax, Hemothorax, Pneumothorax, Lung Laceration

DOI: 10.4328/ACAM.22081 Received: 2023-12-21 Accepted: 2024-02-12 Published Online: 2024-02-21 Printed: 2024-03-01 Ann Clin Anal Med 2024;15(3):204-209
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This study was approved by the Ethics Committee of Kahramanmaraş Sütçü İmam University, Faculty of Medicine (Date: 2023-03-14, No: 04)

Introduction

Penetrating thoracic traumas are divided into two groups: penetrating injuries and injuries with firearms. These injuries account for 30% of all traumas [1]. On the other hand, firearm injuries have high pressure resulting in severe damage to the surrounding tissue [2]. Penetrating thoracic traumas constitute 30% of all traumas [3]. Some chest wounds are life-threatening emergencies often associated with intrathoracic injury [4, 5]. Most low-velocity penetrating injuries do not require surgical treatment. Hence, tube thoracostomy is sufficient [6, 7]. Asymptomatic patients can be followed up with chest x-rays or computerized tomography [8]. However, sternotomy or thoracotomy may be required due to extensive pulmonary injury, intrathoracic major vascular injuries, and cardiac injuries[9].

Within the scope of this study, it was aimed to elucidate the risk factors affecting penetrating chest injuries, their etiology, demographic characteristics of the injured, severity of injury, accompanying organ injuries, treatment options, length of hospital stay and need for intensive care. and transfusion requirements, morbidity, and mortality.

Material and Methods

The data of 130 patients who were admitted to Kahramanmaraş Sütçü İmam University Faculty of Medicine and Kahramanmaraş Necip Fazıl City Hospital due to penetrating chest trauma between January 2016 and January 2023 were retrospectively examined.

Iatrogenic causes and penetrating thoracic traumas caused by any foreign body were also included in the study. These were included in the sharps injuries group. Cases with blunt thoracic trauma and those under the age of 18 were excluded from the study.

The intervention performed when we first accepted the case was considered the first intervention, and the interventions that were needed later during the follow-up or performed by other surgical departments were considered the second intervention. The groups that needed intensive care and those that did not need intensive care were compared in terms of mortality, morbidity and complications. The patients who are injured by gunshots were compared with those injured by sharp objects.

The age, gender, injury mechanism and instruments, localization of injury, affected organs, first and second interventions, length of stay, and the requirement for intensive care and blood transfusion were obtained from the hospital's electronic database. Additionally, complications and mortality rates were recorded. Mortalities were those that occurred during hospital follow-up.

Statistical Analysis

Patient data were analyzed with the IBM Statistical Package for the Social Sciences (SPSS) for Windows 28.0 program. Frequency and percentage were given as descriptive values for categorical data, and mean and standard deviation were given for continuous data. The distribution of variables was measured by the Kolmogorov-Smirnov test. Mann-Whitney-U test was used for quantitative independent variables, "the Pearson Chi-Square Test" was used to compare categorical variables, and the Fischer test was applied when the Chi-Square test conditions were not met.

Results were considered statistically significant when the P value was less than 0.05.

Ethical Approval

This study was approved by the Ethics Committee Kahramanmaraş Sütçü İmam University, Faculty of Medicine (Date: 2023-03-14, No: 04).

Results

Within this research, 130 patients with penetrating thoracic trauma were analyzed retrospectively. Of the cases, 109 (83.8%) were male and 21 (16.2%) were female. The mean age of the participants was 35.2±17.8 years. The mechanism of injury was a cutting tool in 88 (67.7%) cases. The most common type of thoracic injury was pneumothorax in 102 (78.5%) cases. Diaphragmatic injury was seen in 22 (16.9%) of the cases. Injury mechanism and injury types are given in Table 1. Pneumothorax, hemothorax, contusion, pulmonary laceration, diaphragm, liver, and spleen wounds were significantly higher in intensive care patients ($p<0.05$). The need for an initial intervention was significantly lower ($p<0.05$), while thoracotomy and tube intervention were significantly higher ($p<0.05$) in intensive care patients. As expected, the complication rate, mechanical ventilation, and blood transfusion requirements were significantly higher in the intensive care unit patients ($p<0.05$). The parameters in the groups with and without intensive care requirements are given in table 2. Rib fractures, soft tissue injury, pulmonary contusion, pulmonary laceration, subcutaneous emphysema, pneumo-mediastinum, and extremity wounds were significantly higher in the group with gunshot injury than in the other group ($p<0.05$).

In cases with a gunshot injury, thoracotomy was the first intervention, and this was statistically significant compared to the intervention in ordinary cut injuries ($p<0.05$). The tube intervention was significantly lower in gunshot wound patients ($p<0.05$).

Mechanical ventilator requirement and blood transfusion rate were significantly higher in the gunshot injury group ($p<0.05$) (Table 3).

Discussion

Penetrating thoracic traumas are more common in the younger age group although they are also relatively high in the second and fourth decades. The mean age of the subjects in this research was 35.2±17.8 years, which is similar to the literature [10]. Penetrating thoracic traumas are common in men since the use and supply of firearms can be accessed more easily compared to women. In a study by Lundin et al., the proportion of men was very high in our study. In our study, the injury rate of men was approximately five times higher than that of women [11].

Penetrating thoracic traumas occur with gunshot and stab wounds. These ratios may differ according to the geographies, regions, and occupations in the literature. In our study, the most common injury mechanism in the patients (67.7%) was cut wounds. Firearm gunshot wounds are expected to be higher in the military compared to other individuals [12]. Robison et al. reported the distribution of firearm gunshot wounds and penetrating traumas as 32.8% and 67.2%, respectively. Our

study is similar to the literature in this respect [13].

Pneumothorax, as in published articles, was the most common type of intrathoracic injury in our analysis. However, our pneumothorax rates were quite high (78.5%) compared to the previous literature. This rate has been reported as 23.5% by Karamustafaoglu et al. and 44% by Kong et al. [14,15]. This may be attributed to the inclusion of iatrogenic injuries. In our study, it was observed that all iatrogenic injuries resulted in pneumothorax.

Various extremity injuries have been reported in our series within extrathoracic injuries. These injuries have been described in a wide range from skin injuries where primary repair is sufficient to extremity injuries requiring bone fixation. Gunshot wounds resulted in injuries leading to limb fractures. Due to the high kinetic energy of gunshot injuries, it has been observed that large bones cause fractures that require surgical treatment. Similar to the literature, bone fractures were also observed in our series [16].

Loogna et al. stated that liver and diaphragm injuries were the most common intra-abdominal organ injuries causing penetrating thoracic traumas. In addition, Demetriades et al. indicated that diaphragm injury was the most frequent injury type accompanying penetrating thoracic traumas . In our study, the most common intra-abdominal organ injuries were diaphragm injuries [17,18]. The incidence of these accompanying extrathoracic pathologies varies between 30 – 35%. Injuries to these organs cause perfusion and oxygenation disorders throughout the body, leading to morbidity and mortality [19]. In our study, extrathoracic organ injuries negatively affected morbidity and length of hospital stay.

As a result of the initial evaluation in our study, tube thoracostomy was the most commonly applied approach. Compared to a study

Table 1. The characteristics of firearm gunshot traumas and piercing cutting tool injury

		Firearm Gunshot Trauma				Piercing Cutting Tool İnjury				P value	
		Median±SD/n-%			Median	Median±SD/n-%			Median		
Age		30.6	±	13.4	25.0	36.5	±	18.7	31.0	0.141	m
Gender	Female	7		24.1%		14		13.9%		0.185	X²
	Male	22		75.9%		87		86.1%			
Localization	Right	13		44.8%		33		32.7%		0.326	X²
	Left	13		44.8%		61		60.4%			
	Left + Right	3		10.3%		7		6.9%			
Length of hospital stay		8.8	±	5.0	7.0	6.7	±	3.9	7.0	0.064	m
Type of İnjury											
Rib Fracture		23		79.3%		9		8.9%		0.000	X²
Soft Tissue		20		69.0%		30		29.7%		0.000	X²
Pneumothorax		22		75.9%		80		79.2%		0.699	X²
Hemothorax		24		82.8%		65		64.4%		0.060	X²
Contusion		25		86.2%		4		4.0%		0.000	X²
Pulmonary Laceration		16		55.2%		20		19.8%		0.000	X²
Subcutaneous Emphysema		18		62.1%		33		32.7%		0.004	X²
Pneumo-mediastinum		11		37.9%		8		7.9%		0.000	X²
Diaphragm Injury		5		17.2%		17		16.8%		0.959	X²
Liver Injury		1		3.4%		8		7.9%		0.403	X²
Colon Injury		5		17.2%		7		6.9%		0.091	X²
Kidney Injury		1		3.4%		2		2.0%		0.534	X²
Spleen Injury		3		10.3%		9		8.9%		0.814	X²
Stomach Injury		3		10.3%		3		3.0%		0.124	X²
Head & Neck Injury		1		3.4%		6		5.9%		1.000	X²
Extremity Injury		9		31.0%		7		6.9%		0.000	X²
Heart Injury		3		10.3%		1		1.0%		0.035	X²
Veins Injury		2		6.9%		5		5.0%		0.682	X²

m Mann-whitney u test / X² Chi-square test (Fischer test)

Table 2. Parameters in cases requiring intensive care

		Intensive Care (-)				Intensive Care (+)				p	
		Median±SD/n-%			Median	Median±SD/n-%			Median		
Age		37.1	±	16.0	30.0	34.4	±	15.0	30.5	0.921	m
Gender	Female	4		10.8%		17		18.5%		0.286	X^2
	Male	33		89.2%		75		81.5%			
Localization	Right	15		40.5%		31		33.7%		0.460	X^2
	Left	18		48.6%		55		59.8%			
	Right+Left	4		10.8%		6		6.5%			
Length of hospital stay		3.4	±	1.0	3.0	8.6	±	0.0	7.0	0.000	m
Mechanism of İnjury											
Gunshot Wound		8		21.6%		21		22.8%		0.338	X^2
Piercing Cutting Tool Injury		23		62.2%		64		69.6%			
İatrogenic		6		16.2%		7		7.6%			
Type of İnjury											
Rib Fracture		7		18.9%		25		27.2%		0.326	X^2
Soft Tissue İnjury		21		56.8%		29		31.5%		0.008	X^2
Pneumothorax		15		40.5%		86		93.5%		0.000	X^2
Hemothorax		13		35.1%		75		81.5%		0.000	X^2
Pulmonary Contusion		4		10.8%		25		27.2%		0.044	X^2
Pulmonary Laceration		3		8.1%		33		35.9%		0.001	X^2
Subcutaneous Emphysema		23		62.2%		28		30.4%		0.001	X^2
Pneumomediastinium		3		8.1%		16		17.4%		0.178	X^2
Diaphragm Injury		0		0.0%		21		22.8%		0.001	X^2
Liver Injury		0		0.0%		9		9.8%		0.049	X^2
Coloninjury		2		5.4%		10		10.9%		0.334	X^2
Kidney Injury		0		0.0%		3		3.3%		0.557	X^2
Spleen Injury		0		0.0%		11		12.0%		0.028	X^2
Stomach Injury		0		0.0%		6		6.5%		0.181	X^2
Head & Neck Injury		2		5.4%		5		5.4%		0.995	X^2
Extremity Injury		2		5.4%		14		15.2%		0.126	X^2
Heart Injury		2		5.4%		2		2.2%		0.324	X^2
Veins Injury		1		2.7%		6		6.5%		0.386	X^2

mMann-whitney u test / X^2 Ki-kare test (Fischer test)

Table 3. The route of intervention, complications and other health related requirements according to the duration of hospital stay

		Length of hospital stay< 7days		Length of hospital stay ≥ 7 days		p	
		n	%	n	%		
Initial Intervention	Follow-Up	24	41.4%	1	1.4%	<0.001	X^2
	Thoracotomy	2	3.4%	29	40.3%	<0.001	X^2
	Chest Tube	29	50.0%	42	58.3%	0.343	X^2
	Wound Healing	3	5.2%	0	0.0%	0.125	X^2
Second Intervention		27	46.6%	33	45.8%	0.935	X^2
Complication		1	1.7%	21	29.2%	<0.001	X^2
Intensive Care Unit		27	46.6%	65	90.3%	<0.001	X^2
Mechanical Ventilator		1	1.7%	31	43.1%	<0.001	X^2
Transfusion Requirement		7	12.1%	47	65.3%	<0.001	X^2
Result	Live	57	98.3%	68	94.4%	0.259	X^2
	Ex	1	1.7%	4	5.6%		
Length of hospital stay	< 7 Days	57	98.3%	68	94.4%	0.259	X^2
	≥ 7 Days	1	1.7%	4	5.6%		

X^2 Ki-kare test (Fischer test)

conducted in our country, our tube thoracostomy rates are quite high compared to the conservative treatment approach [20]. The low rate of conservative approach to cases brought with penetrating trauma has been one of the factors contributing to survival.

With our mortality rate in our study was significantly different from the literature and was found to be %3.8. To the best of our knowledge, the lowest mortality rate reported in the literature is in our study. One of the reasons for this result is that we act more aggressively, especially in left hemithorax and parasternal injuries. In the literature, it is mentioned that more care should be taken in left hemithorax injuries. Injuries, especially to the left front of the chest, should be treated as if they were a heart injury until proven otherwise [21]. In addition, in our study, thoracotomy was preferred more in gunshot wounds due to the high kinetic energy of the bullet and the unpredictability of its path in the thorax. This preference is one of the reasons why our mortality is low.

In autopsy studies, 96.4% of the deaths in thoracic traumas were due to bleeding. The morbidity and mortality in cases with multiple organ trauma were increased compared to cases with isolated thoracic trauma. The causes of mortality were multiple organ dysfunction, acute respiratory distress syndrome, pulmonary embolism, crush syndrome, brain edema, sepsis, disseminated intravascular coagulation, and cerebrovascular events [22]. In our study, two of the five mortal cases were in the firearm injury group. The other two were patients followed in the intensive care unit due to multiple organ failure. These patients were in the iatrogenic injury group. Deaths in the gunshot injury group were due to massive hemorrhage and deaths in the iatrogenic injury group were due to multiple organ failure.

In our study, we preferred surgical intervention instead of conservative treatment, especially in gunshot injuries. Therefore, our thoracotomy rates are high in gunshot wounds. In addition, we performed surgical procedures for left hemithorax or parasternal region injuries regardless of the injury type. As a result, our mortality rates were significantly lower than in the literature [23, 24]. We have kept our intensive care indications and intensive care indications in penetrating chest trauma wider than the literature [25]. With this approach, we detected our patients who had a second surgery and needed blood and blood products earlier.

Conclusion

While most stable patients with penetrating thoracic traumas of civilian origin can be treated simply and successfully with initial chest tube placement, these patients should be evaluated comprehensively and systematically for the presence of life-threatening occult conditions. Stable patients should be closely monitored and repeatedly examined until study completion because there is potential for rapid decompensation and death due to initially unrecognized intrathoracic injuries. The presence of heart and large vessel injuries should be taken into consideration in gunshot wounds, injuries to the anterior chest wall and parasternal area.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or compareable ethical standards.

Funding: *None*

Conflict of Interest

The authors declare that there is no conflict of interest.

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How to cite this article:
Fatoş Kozanlı, Ahmet Karslıgil. *Our initial evaluation and clinical approaches in penetrating thoracic. Ann Clin Anal Med 2024;15(3):204-209*

This study was approved by the Ethics Committee of Kahramanmaraş Sütçü İmam University, Faculty of Medicine (Date: 2023-03-14, No: 04)