

Clinical Research

Analysis of Patients with Chest Trauma Undergoing Urgent Thoracotomy

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ABSTRACT

Objective: Emergency Thoracotomy is a surgery procedure performed for patients with blunt and penetrating thoracic trauma. In this study, patients with thoracic trauma performed emergency thoracotomy were examined retrospectively. The result obtained was discussed related to literature.

Material and methods: Between 2010 and 2014, 22 patients, which have undergone urgent thoracotomy in operation room due to thoracic trauma, were evaluated retrospectively. Patients were divided into two groups as direct thoracotomy (group 1) or thoracotomy after tube thoracostomy (group 2) groups. Age, sex, location and type of trauma, associated injuries, blood transfusion, modified early warning score (MEWS) values, the time to arrival at hospital, surgical procedures, pathologies seen and repaired in operation, complications, length of stay in hospital, mortality and morbidity rates were analyzed. Also the effects of sex, location and type of trauma, associated injuries, MEWS values and time to arrival at hospital on the mortality were evaluated. Statistically, continuous variables were expressed as mean \pm standard deviation, categorical variables were explained as number and percentage. Results of analysis were evaluated using Fisher's exact test. $P < 0.05$ was considered as significant.

Results: The average age was 26 ± 6.7 . There were 6 patients in group one, 20 patients in group two. Penetrating injuries were found in 20 of the patients, and blunt trauma was identified in 2. Statistically, correlation was found between mortality and the presence of concomitant injuries, time to arrival at hospital over one hour and MEWS scoring values > 9 .

Conclusion: Fast and accurate interventions reduced morbidity and mortality in thoracic injuries.

Key words: Emergency, Thoracotomy, Blunt, Penetrating

ÖZET

Acil Torakotomi Yapılan Göğüs Travmalı Hastaların Analizi

Amaç: Acil torakotomi, künt ve penetran toraks travmalı hastalarda acil serviste ya da ameliyathanede uygulanan bir cerrahi müdahaledir. Çalışmamızda, acil torakotomi yapılan hastalar retrospektif incelendi. Elde edilen sonuçlar literatür eşliğinde tartışıldı.

Metaryel ve Metod: Ocak 2010-Aralık 2014 tarihleri arasında toraks yaralanması nedeniyle ameliyathanede acil torakotomi yapılan 22 hastanın dosyaları retrospektif incelendi. Direkt torakotomi (grup 1) yada tüp torakostomi sonrası torakotomi (grup 2) yapılan hastalar olarak iki grup oluşturuldu. Yaş, cinsiyet, yaralanma yeri, travmanın tipi, yandaş yaralanmalar, transfüzyon ihtiyacı, modifiye erken uyarı sistemi (MEWS) skorlama değerleri, hastaneye ulaşım süreleri, cerrahi yöntemler, operasyonda görülen ve onarılan yaralanmalar, komplikasyonlar, yatış süreleri, mortalite ve morbidite oranları tespit edildi. Cinsiyetin, travma tipinin, yandaş yaralanmaların, MEWS skorlama değerlerinin, hastaneye ulaşım sürelerinin ve travma yerinin mortaliteye olan etkisi değerlendirildi. İstatistiksel analizde, sürekli değişkenler, ortalama \pm standart sapma, kategorik değişkenler, sayı-oran olarak ifade edildi. Sonuçların anlamlılıkları, Fisher's exact testi ile değerlendirildi. $P < 0,05$ anlamlı kabul edildi.

Bulgular: Hastaların ortalama yaşı 26 ± 6.7 idi. 20'si erkek, 2'si kadındı. Yirmi hastanın penetran, 2'sinin künt travma olduğu görüldü. Grup 1, 6 hasta, grup 2 ise 16 hastadan oluşmaktaydı. Penetran travmalı 2, künt travmalı 1 hasta kaybedildi. İstatistiksel analizde yandaş yaralanma varlığının, MEWS skorunun 9'dan yüksek olmasının ve hastaneye ulaşma süresinin 1 saatten fazla olmasının mortalite oranıyla korelasyon gösterdiği tespit edildi.

Sonuç: Hızlı ve doğru yapılan müdahaleler, toraks yaralanmalarında morbidite ve mortaliteyi azaltır.

Anahtar Sözcükler: Acil, Torakotomi, Künt, Penetran

Emergency thoracotomies are classified as emergency services and rapid thoracostomy. This classification is done according to thoracotomies performed in emergency services before transportation of the patients and urgent thoracotomies performed in the operating room apart from emergency services. Additionally, there are thoracotomies applied to patients whose general condition is bad and getting worse (1). It was first used for open heart massage by Moritz Schiff. It subsequently began being used for

heart injuries, penetrating chest injuries and temporary thoracic aorta occlusion (2). These thoracotomies vary depending on time of procedure, site of procedure and the patient's physiological condition during the procedure (3).

Emergency department thoracotomy is a thoracotomy performed in the emergency department on trauma patients in extremis using a left anterolateral incision from the 4th or 5th intercostal space. It should not be confused with thoracotomy performed in the operating theater or intensive care unit (4).

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Survival rates after emergency department thoracotomy of 0% - 64% have been reported (5). The best results have been reported in isolated penetrating heart injuries. The rates fall to 1% - 3% in cases of prolonged time to hospital and multiple traumas. Better outcomes have been reported in thoracotomies performed in the operating theater or intensive care unit (6).

In this study, our aim is to share our results of emergency thoracotomies performed in the operating room (urgent) in the light of related literature.

MATERIALS AND METHODS

Patients: The files of 22 patients with thoracic trauma who underwent emergency thoracotomy in operation room between 2010-2014 were analyzed retrospectively.

Study design: All patients' files were examined. Patients were divided into two groups according to the treatment performed as direct thoracotomy (group 1) or thoracotomy after tube thoracostomy (group 2). For both groups, physical examination (breathing pattern, consciousness, location and type of injury), vital (pulse and blood pressure) and radiological findings (chest graphy and computed tomography) of patients in both groups were evaluated. Patients were scored with modified early warning system (MEWS; pulse, respiratory rate, state of consciousness, systolic blood pressure). In addition to age, sex, associated injuries, blood transfusion, the time to arrival at hospital, surgical procedures, pathologies seen and repaired in operation, complications, length of stay in hospital, mortality and morbidity rates were examined. Reasons

operation, complications, length of stay in hospital, mortality and morbidity rates were examined. Reasons caused direct thoracotomy or thoracotomy after tube thoracostomy in patients with thoracic trauma were evaluated. Furthermore, the effects of sex, location and type of trauma, associated injuries, MEWS values and times to arrival at hospital on the mortality were evaluated.

Statistical analysis: In statistical analysis, continuous variables were expressed as mean \pm standard deviation, and categorical variables were explained as number-ratio. The significance of the results was assessed by Fisher's exact test. P values under 0.05 were considered significant.

Ethics: Our retrospective study has been approved by Ethics Committee of Dicle University of Medicine (Confirmation number: 225, Approval date: 15.05.2015).

RESULTS

The average age of patients were $26 \pm 6,7$. Two of the patients (9%) were female. On the other hand, 20 (91%) of them were male. Penetrating injuries were found in 20 (91%) of the patients, and blunt trauma was identified in 2 (9%). While 85% (n = 17) of the penetrating injuries were stab wounds (SW), 15% (n = 3) were gunshot wounds (GW). As for the blunt trauma 50% (n = 1) were caused by traffic accidents (TA), 50% (n = 1) were falling from height (FH). Site of injury was the right hemithorax in 8 patients (36%) and the left hemithorax in 14 (64%). Accompanying injury was present in 4 patients (18%) (spleen, diaphragm, heart and liver (Table 1)).

Table 1. Analysis of patients undergoing urgent thoracotomy

Localization	n	M/F	Organ loss	Associated Organ injury	Ex	Blood transfusion
Right (SW)	5	M: 5	Middle lobe			+
Left (SW)	12	M/F: 11/1	Spleen	Spleen + Diaphragma	1	+
				Heart	1	1
Right (GW)	2	M: 2		Heart + Diaphragma + Liver + Colon	1	1
Left (GW)	1	F: 1				+
Right (Blunt)	1	M: 1				+
Left (Blunt)	1	M: 1		Diaphragma + Stomach and Colon herniation	1	1
Total	22	20/2			4	3

N: Number, **M:** Male, **F:** Female, **SW:** Stab wounds, **GW:** Gunshot wounds, **Ex:** Exitus

Group 1 (n = 6, 27%) consisted of patients who underwent direct thoracotomy. While five of (83%) these patients were penetrating trauma, one patient (17%) was blunt trauma. SW was present in 4 (66%) of the penetrating injuries and GW in 1 (17%). One patient with blunt trauma was FH. MEWS score was

found to be higher than 9 for the patients in this group. Moreover, it was discovered that heart, great vessels, liver, and diaphragm injuries or radiological massive hemothorax existed (Table 2,3). It was also observed that 4 of the patients underwent standard posterolateral thoracotomy, 1 of the patients had anterolateral

thoracotomy considering heart and lung injuries, and 1 of the patients underwent sternotomy considering heart or internal mammarian artery injuries. Pulmonary parenchyma injury and associated air leak and parenchymal bleeding were observed intraoperatively in all patients. Intercostal artery injury was present in two (33%) of the cases of penetrating injury, internal mammary artery injury in one patient (17%), heart injury in two patients (33%) , and

diaphragm (17%), liver (17%) and colon (17%) injury in one. Rib fractures (17%), diaphragm rupture (17%) and herniation of the stomach and colon into the thorax were observed in the patient with blunt trauma. One patient with SW, one with GW and one patient with blunt trauma died. Accompanying injuries (heart, diaphragm and colon) were present in all the patients who died and the duration of hospital transportation for the patients who died was longer than 1 hour (Table 2)

Table 2. MEWS scoring system

Score	3	2	1	0	1	2	3
Pulse	X	< 41	41-51	51-100	101-110	111-130	> 130
Resp.rate	X	< 9	X	9-20	X	21-30	> 30
CNS level	Unresponsive	Pain	Voice	Alert	New agitation or confuse	X	X
SBP	< 71	71-80	81-100	101-200	X	> 200	X

Mews: Modified early warning system, **CNS:** Central nervous system, **SBP:** Blood pressure, **Resp:** Respiratory

Table 3. Intraoperative findings in patients undergoing urgent thoracotomy

Intraoperative findings	Group 1		Group 2	
	Blunt (n:1)	SW/GW (n:4/1)	Blunt (n:1)	SW/GW (n:13/2)
Parenchymal damage	1	4/1	1	13/2
Intercostal artery injury	-	2/0	-	4/0
Mammary artery injury	-	1/0	-	2/0
Heart injury	-	1/1	-	-
Diaphragmatic injury	1	1/0	-	1/0
Spleen injury	-	-	-	1/0
Liver injury	-	1/0	-	-
Costa fracture	1	-	1	-
Chest wall defect	-	-	-	1/0
Colon injury	-	1/0	-	-

N: Number, **SW:** Stab wounds, **GW:** Gunshot wounds

Group 2 (n = 16, 73%) consisted of patients underwent thoracotomy following tube thoracostomy in the emergency or intensive care departments. Fifteen patients (94%) had penetrating injury and 1 (16%) blunt trauma. Thirteen (87%) of the penetrating injuries were SW and 2 (13%) were GW. The case of blunt trauma (6%) was caused by an in-vehicle traffic accident. It was found that the patients in this group had better vital signs and physical examination findings compared to patients in group 1. However, it was observed that the patients' state of health worsened clinically and radiologically after tube thoracostomy. Additionally, it was seen that 13 patients having hemorrhagic drainage around 1000 - 1500 cc and developed hypotension, tachycardia, and loss of consciousness after tube thoracostomy. Two patients having subcutaneous emphysema and massive air leak after tube thoracostomy, and developing chest wall defects and bleeding from after tube thoracostomy were operated. Fourteen of the patients underwent standard posterolateral thoracotomy, one patient

underwent anterolateral thoracotomy considering heart, internal mammarian artery and a lung injuries.

Intraoperatively, pulmonary parenchyma injury, bleeding and air leak were observed in 16 patients (100%), intercostal artery injury in four patients (25%), internal mammarian artery injury in two patients (13%), diaphragm laceration in one patient (6%), splenic injury in one patient (6%), and chest wall defect in one patient (6%). Middle lobectomy was performed on one patient with penetrating injury due to the active parenchymal hemorrhage and splenectomy on one patient. Displaces rib fracture and bleeding and air leak associated with pulmonary injury were identified in one patient with blunt injury (Table 3).

For both groups, it was found that the lung parenchyma repair was done with 3/0 absorbable (vicryl) sutures, and artery and diaphragmatic repair were done with sutures not absorbed (prolene), and fixation for rib fractures was performed to a blunt

trauma patient. Blood transfusion was performed on all patients. In the postoperative period, all patients were monitored in the intensive care unit.

Analysis of these patients undergoing emergency thoracotomy was based on such variables as gender, type of trauma, presence of accompanying injury, MEWS scoring value, time to arrival at hospital and site of trauma.

The independent variables gender ($p = 1.00$), trauma type ($p = 0.25$) and site of trauma ($p = 0.12$) were not correlated with mortality ($p > 0.05$). However, presence of accompanying injury ($p = 0.002$), MEWS scoring value above 9 ($p = 0.01$) and time to hospital longer than 1 hour ($p = 0.004$) were correlated with mortality and morbidity ($p < 0.05$) (Table 4).

Table 4. Outcome analysis of prognostic factors in patients undergoing urgent thoracotomy

Variable	Outcome	Alive/Dead	P value
Sex			
Male	20	17/3	1.00
Female	2	2/0	
Total	22	20/2	
Type of chest trauma			
Blunt	2	1/1	0.25
Penetrating	20	18/2	
Total	22	20/2	
Associated injury			
Present	4	1/3	0.002
Not present	18	18/0	
Total	22	19/3	
MEWS score on admission			
≤ 9	19	19/0	0.01
> 9	3	1/2	
Total	22	20/2	
Duration between injury and arrival			
< 1 h (approximately 30 minutes)	20	20/0	0.004
> 1 h	2	0/2	
Total	22	20/2	
Location of chest trauma			
Right	8	6/2	0.12
Left	14	14/0	
Total	22	20/2	

P value (With Fisher exact testing): Significant degree, **MEWS:** Modified early warning system

Atelectasis developed in two patients (9%) during monitoring, wound site infection in three patients (14%), empyema in one patient (5%), pneumonia in one patient (5%) and intraparenchymal hematoma in one patient (5%). These complications were brought under control with appropriate treatments. Tube thoracostomies were ended in 6 ± 2.7 days on average. Mean length of hospitalization was 8 ± 4 days. All patients were discharged in a healthy condition. It was found that the patients' 3 months and 1 year checks were normal.

DISCUSSION

Emergency thoracotomy is done in most cases as a major therapeutic intervention. It is resorted for quick reversal of worsening situations like major chest trauma, cardiac arrest and other similar conditions. It may serve as a life-saving tool when performed for the right indications, in selected patients and in the hands of trained surgeons (7).

Emergency thoracotomy applied during trauma treatment is one of the controversial techniques performed by trauma surgeons or emergency surgeons. Emergency department thoracotomy is defined as thoracotomy performed in the emergency department on patients in extremis with a right/left anterolateral incision through the 4th or 5th intercostal space.

Scene of incident thoracotomy performed outside the emergency department before arrival at the emergency department and thoracotomy performed in the operating room after emergency assessment are also included within the definition of emergency thoracotomy (4,8). The thoracotomies in this study involved patients who underwent thoracotomy in the operating room after emergency assessment or after tube thoracostomy.

Indications for emergency department thoracotomy in blunt and penetrating thoracic traumas were penetrating injury patients having less than 15

minutes cardiopulmonary resuscitation before hospitalization, blunt trauma patients having less than 5 minutes of cardiopulmonary resuscitation before hospitalization, and post-traumatic severe hypotension, cardiac tamponade, intrathoracic haemorrhage, and clamping the descending aorta (1). It should be performed rarely in blunt traumas because of the lower patient survival rates and it should be performed with patients exposed to blunt trauma and arriving at the trauma center with vital findings and in whom cardiac arrest develops subsequently. In penetrating injuries, the guideline states that it should be performed with patients with or without witnessed vital signs and patients with non-cardiac thoracic injury (9). One of the two patients with blunt trauma injury in our study died (mortality: 1/2, %50). In addition, much better results were obtained in patients with penetrating injuries (mortality: 2/20, %10).

According to Cothren et al. (4) pre-hospital cardiopulmonary resuscitation (CPR) lasting less than 15 minutes in penetrating traumas and pre-hospital CPR lasting less than 5 minutes in blunt traumas were regarded as indications, while CPR lasting more than 15 min in hospital in penetrating traumas and more than 5 minutes in blunt traumas was regarded as a contraindication. The patients in Group 1 brought to the emergency department consisted of patients sufficiently critical on the basis of MEWS to require no loss of time. Four patients had a MEWS higher than 9, and three of these four patients died ($p < 0.05$).

After tube thoracostomy, thoracotomy indications were sudden 1000 - 1500cc or 20cc/kg hemorrhage after tube thoracostomy, sudden 100cc/kg hemorrhage during the first 6-8 hours after tube thoracostomy, 250cc/hour bleeding during the first 3 hours after tube thoracostomy and clinical symptoms related to continuing bleeding (10). In our study, indications of

our patients after the tube thoracotomy were consistent with the literature.

Studies have reported higher levels of thoracic injury and thoracotomy in males than in females, and that although the risk of mortality is higher in young males; gender was not a variable that significantly affected mortality (11). In our study too, the level of thoracic injuries was higher in males, in agreement with the literature, although gender did not have a significant effect on mortality ($p > 0.05$).

The best results have been reported in isolated penetrating heart injuries. In contrast, the level in cases of blunt trauma with delayed arrival at hospital is 1-3%, and survival is reported to be associated with neurological sequelae. In an analysis of 24 separate studies, Rhee et al. determined survival levels of 19.4% in isolated cardiac injuries, 16.8% in piercing injuries, 4.3% in firearm injuries and 1% in blunt injuries (6). We determined a high survival rate in patients with penetrating injuries in this study (Total: 90%, SW: 94%, GW: 67%). Two patients with penetrating heart injury died. These patients had longer arrival at hospital times than other patients. We attribute the deaths of two patients with heart injuries being concomitant injuries and time to arrival at hospital exceeding 1 hour. The survival rate in patients with blunt trauma was 50%. The patient who died had multiple organ injuries.

As a result, as well as immediate transferring, diagnosis and treatment, close monitoring of patients with the thoracic trauma for emergency thoracotomy to be performed after tube thoracostomy has a vital importance for the patients. Early decided and performed thoracotomy without loss of time can be life-saving.

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