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Original article

Emergency thoracotomy: Experience of one year in a large tertiary trauma center

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Abstract

Introduction: Emergency thoracotomy (ET) can be a life-saving procedure in highly selected trauma patients, especially after penetrating chest trauma. The aim of this work was to evaluate the outcome in trauma patients who were admitted to the Alexandria Main University Hospital (AMUH) during 1 year period and underwent ET as a management and to compare our results with that documented in the literature.

Patients and methods: This is prospective clinical study included trauma patients who were admitted to AMUH during 1 year period (August 2013–August 2014) and underwent ET. Analysis of the cause of trauma, age, sex, different tools of investigations used, concomitant organ injuries, systolic blood pressure (SBP), Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Trauma Revised Injury Severity Score (TRISS) and mortality rate were performed.

Results: Twenty-two patients who had ET were included in this study (All were males, Age range: 5–45 years; median: 23.5 ± 7.83 years). Twenty patients from twenty-two were survived. Two of them had blunt trauma while 18 had penetrating injuries. The most frequent injury encountered was isolated thoracic injury ($n = 13$). Thoracotomy was performed in 20 patients, sternotomy in two, and one patient underwent additional laparotomy. Median ISS and TRISS were 10 (*Range 9–29*) and 0.98 (*Range 0.54–0.99*), respectively. Blood transfusion ranged between 1 and 13 units with a median of 2 units of packed red blood cells. The median time from admission to operating room was 37.50 min. Pre-operative (FAST & Thoracic Ultrasound) was done in 90.9% of patients. Most common indication for thoracotomy was shock (SBP < 90). The mortality rate was 9.1% for all patients and 10% for patients with penetrating trauma. Factors affecting mortality was ISS and the amount of blood transfusion.

Conclusion: ET procedure is an important tool in management of selected trauma patients. Rapid assessment, multidisciplinary approach, good resuscitation and prompt surgical intervention reduce the mortality and improve the outcome.

Keywords: Emergency thoracotomy; Chest trauma; Thoracic injuries; Blunt chest trauma; Penetrating chest trauma

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1. Introduction

Thoracic trauma is accounting for about 25–50% of all fatal injuries [1]. The majority of patients with thoracic trauma can be managed non-operatively, with or without tube thoracostomy. However, there is still a small, but significant (10–15%), sub-group of thoracic trauma victims who require emergency thoracotomy (ET) [2]. ET has become an established procedure in the management of life-threatening thoracic trauma [3,4]. The aim of this work is to evaluate the outcome in trauma patients who were admitted to the Alexandria Main University Hospital (AMUH) during 1 year period and underwent ET as a management and to compare these results with that documented in the literature.

2. Patients and methods

This is a prospective clinical study included patients with trauma who were admitted to AMUH during 1 year period (August 2013–August 2014) and underwent ET. There is no sex or age restriction. Exclusion criteria included patients who have elective thoracotomy or medical or non-traumatic emergency thoracotomy, patients who had arrest pre-hospital or had arrived with no signs of life.

Analysis of the cause of trauma, age, sex, different tools of investigations used, concomitant organ injuries, systolic blood pressure (SBP), Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Trauma Revised Injury Severity Score (TRISS), morbidity and mortality were performed. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS 20). Differences were considered to be significant at the $p \leq 0.05$ probability level.

3. Results

During 1 year period (Aug 2013 to Aug 2014), twenty-two patients with chest trauma underwent ET in AMUH. All patients were males. The mean of age was 25.18 ± 9.34 (range 5–45 years, median: 23.5 ± 7.83 years). Two patients had blunt injuries (9.1%) and twenty patients (90.9%) presented with penetrating injuries. The mean length of hospital stay (LHS) was 4.73 ± 5.29 (range 1–20) days. Eighteen patients (81.8%) were hospitalized for ≤7 days. Table 1 demonstrates the distribution of the patients according to the mechanism of injury.

Thirteen (59.1%) patients had isolated thoracic injuries, while nine (40.9%) had associated injuries including abdominal injuries, head injuries and injuries at extremities ($n = 4$ (18.2%), $n = 3$ (13.6%) and $n = 10$ (45.4%) patients respectively).

The mean pulse was 109.32 ± 20.14 b/min, and the mean SBP was 75.0 ± 32.77 mmHg. The mean respiratory rate was 28.04 ± 8.68 breath/min. The mean GCS was 13.09 ± 3.02 and the mean of the Revised Trauma Score, ISS and TRISS were 6.66 ± 1.15, 12.68 ± 5.07 and 0.93 ± 0.11 respectively. The mean time from admission to operating room was 3.03 ± 10.06 h (range = 20 min to 2 days).

Beck's triad was clinically evident in five (22.7%) patients. In four of them (80%) cardiac tamponade was diagnosed intra-operatively. Cardiopulmonary resuscitation on arrival was performed in one patient (4.5%). Eighteen (81.8%) patients needed blood transfusion; the mean packed red blood cells (RBCs) transfused was 3.06 ± 2.94 units (range 1–13 units). Arterial blood gas analysis (ABG) was done in six (27.3%) patients; where the pH level was <7.2 in 16.6%, and <7.3 in 83.33% of patients. The PCO_2 level was <45 mmHg in 16.6% and the PO_2 level was >75 mmHg in 66.6%. Respiratory acidosis was detected in 50%, while metabolic alkalosis, metabolic acidosis and mixed, were detected in 16.6% for each.

Table 1
Distribution of patients according to mechanism of injury.

Mechanism of injury	No. of patients	%
RTA*	1	4.5
Falling of heavy object on chest	1	4.5
Stab chest	14	63.6
Pellets	4	18.2
Bullets	1	4.5
Penetration by foreign body	1	4.5

*RTA = Road Traffic Accident.

Pre-operative Focused Abdominal Sonogram for Trauma (FAST) with thoracic ultrasound were performed in twenty patients (90.9%). The most common finding was pericardial collection (54.5%). On the other hand, pleural collection and abdominal collection were founded in five (22.7%) and three (13.6%) patients respectively.

Pre-operative Computed Tomography scan (CT) was done in five (22.7%) patients, the percentages of findings were as following: hemothorax (13.6%), pericardial collection (9.1%) and (4.5%) for each finding of pneumothorax, lung contusion, pneumo-mediastinum, fracture ribs, intra-cardiac pellets and abdominal collection.

The indications for thoracotomy were shock (SBP, <90 mm Hg; $n = 13$), suspected cardiac tamponade ($n = 11$), massive air leak ($n = 1$) and open pneumothorax ($n = 1$). Incisions for ET were left lateral in eighteen patients (81.8%; fourteen patients with stab injuries, four patients with gunshot injury, and two patients with blunt trauma), right lateral in two patients (9.1%; $n = 1$ stab injury, $n = 1$ blunt trauma), and sternotomy in two patients (9.1%; $n = 1$ gunshot injury, $n = 1$ stab injury). One patient (4.5%) underwent a concomitant laparotomy, the intra-abdominal injuries included spleen and colon injuries. Table 2 showed the relationship between the mechanism of injury and the indication of thoracotomy.

Intra-operative findings included release of cardiac tamponade ($n = 11$), management of cardiac injuries ($n = 9$). All cardiac injuries affected the right ventricle. Pulmonary injuries were found in ten patients (45.5%); all affected the left lung. Vascular injuries were found in 6 patients (27.2%) and included the posterior intercostal artery ($n = 2$), left internal mammary artery and vein ($n = 1$), right posterior intercostal artery ($n = 1$), ascending aorta ($n = 1$), superior vena cava (SVC) ($n = 1$). While diaphragmatic tear and tracheal tear were encountered each in one patient (4.5% each). Fourteen patients (63.6%) were admitted to intensive care unit (ICU) post-operatively. Table 3 shows the distribution of patients according to post-operative complications.

4. Discussion

Trauma is one of the leading causes of death in all age groups. The thoracic trauma accounts for about 25–50% of all fatal injuries [1]. The majority of patients with thoracic trauma can be managed non-operatively, however, there is still a small, subgroup of thoracic trauma victims who require ET [2].

ET has become an established procedure in the management of life-threatening thoracic trauma [3,4]. Complications of ET are common and may occur immediately. The most common early complications are respiratory complications [5]. Our results confirm this where our patients showed respiratory complications in twelve patients out of twenty patients (60%) who had ET.

This study showed that stab wounds were the leading cause of penetrating injuries and commonly were encountered in males. It is assumed that males are more affected since they are more involved in violence and more mobile. The same results were detected in other studies [6–8].

All survivors were breathing on arrival at the hospital and had an initial GCS was higher than 10, systolic blood pressure was greater than 70 mmHg, TRISS range (0.54–0.99) (Table 4). Other studies [6,7] has documented comparable results where the survivors had TRISS ranged from 0.64 to 0.99.

The median ISS was higher in blunt injuries (ISS = 16.5) than in penetrating ones (ISS = 9.5). That was found to be statistically insignificant ($p = 0.274$). Similar results were documented in a study that included 4205 patients with chest trauma over 10 years published by Demirhan et al. [9]. Serdar et al. [5] reported that patients who died had a significantly higher ISS (30.71 ± 8.57) than those who survived (17.50 ± 9.19) ($p = 0.001$) and patients suffered from

Table 2
Relationship between the mechanism of injury and the indication of thoracotomy.

Indication of ET	Mechanism of injury										P value
	RTA (n = 1)		Falling of heavy object on chest (n = 1)		Stab chest (n = 14)		Foreign body (n = 1)		Gunshots (n = 5)		
	No.	%	No.	%	No.	%	No.	%	No.	%	
Shock	0	0.0	0	0.0	8	57.1	0	0.0	1	20.0	0.012*
Suspected cardiac tamponade	0	0.0	0	0.0	6	42.9	1	100.0	4	80.0	
Open pneumothrax	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	
Persistent air leak	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	

*Significant.

Table 3
Distribution of patients according to incidence of post-ET complications.

Complications	No.	%
Basal lung atelectasis	6	27.3
Pneumonia	1	4.5
DIC*	1	4.5
ARDS**	1	4.5
Pain	19	86.4
Fever	11	50.0
Residual pneumothorax	4	18.2

*DIC = Disseminated Intra-vascular Coagulopathy.
**ARDS = Adult Respiratory Distress Syndrome.

gun-shot injury tended to have a higher ISS than those admitted with stab injury. This study revealed also that gun-shot injury tended to have a higher ISS than stab injury but the difference was statistically insignificant.

Some studies [5,10,11] reported that stab victims were presented more shocked than gunshot victims, depending on the mean SBP, wherever, the difference was not statistically significant ($p = 0.961$). These results were going with our study as all penetrating trauma victims were more shocked than blunt trauma victims and the difference was not statistically significant.

Rabinovici and Bugaev et al. [12] reported that ABG analysis was performed for twenty-two patients in their study, and 91% of patients were presented with severe acidosis (pH < 7.20). In this study, pH level was less than 7.2 in around 17% of patients. The difference between these two studies can be explained by rapid transfer and good resuscitation measures for patients included in our study.

In this study, FAST was the main diagnostic tool used as it was readily available on demand. These results differed from those reported by Kong et al. [13]. They reported that 109 patients were operated over 6 year's period; predominantly on clinical grounds and only ten patients underwent FAST as part of a diagnostic work-up before operative explorations. They did not have much experience with FAST. Furthermore, Bergros et al. [7] reported that FAST examination was not available in Iceland for the diagnosis of tamponade, and the diagnosis was therefore clinically based. Onan et al. [8] reported that CT was performed in most of patients included in their study.

There was a significant difference between blunt and penetrating trauma, regarding preoperative FAST and CT, $p = 0.044$ and $p = 0.043$, respectively. Many studies reported that the use of FAST has greatly facilitated early detection of hemo-pericardium after penetrating injury [13]. A Cochrane Review has demonstrated that emergency ultrasonography decreases the use of CT scans in blunt abdominal trauma [15]. Some studies reported that left anterior thoracotomy was the most common approach used in ET [5,10,14]. There was a statistical significant difference in the approach of thoracotomy according to age, $p = 0.044$, Nasser et al. [10] reported nearly same results.

All patients with blunt trauma needed chest tube thoracostomy before operation. Only 20% of patients with penetrating trauma needed an insertion of chest tube, the difference between both groups was statistically significant, $p = 0.041$. In our center, we depend on clinical, needle decompression or radiological findings to decide the insertion of chest tube. Demirhan et al. [9] reported that chest tube thoracostomy performed in 73.6% of those with penetrating trauma, because in that study, chest tube insertion was diagnosed on physical examination even if there was no radiological evidence of chest pathology in the chest X-ray.

The most common intra-operative findings were pulmonary injuries, followed by cardiac injuries; Serdar et al. [5] and Demirhan et al. [9] reported the same results. Moreover, these authors reported that atelectasis was the most common complication. We had same results following exclusion of pain, because post-operative analgesic treatment regimen in our center precludes the use of narcotics except in highly selected patients beside that most of patients were drug addicts, hence the post-operative analgesia could not achieve the desired effect.

Overall mortality was (9.1%). 10% of them were recorded in penetrating trauma. This rate was in agreement with some studies [5,16], but it differs from that recorded by Bergros et al. [7] where mortality that recorded in their study was 44.4%, mostly due to blunt trauma.

Table 4
Different measured parameters in relation to type of injury and survival.

Parameter (mean ± SD.)	Stab chest	Gunshot	P value	Survived (n = 20)	Deaths (n = 2)	P value	Penetrating	Blunt	P value
Age (years)	24.50 ± 8.27	27.60 ± 7.83	0.476	24.95 ± 9.48	27.50 ± 10.61	0.722	26.10 ± 8.60	16.0 ± 15.56	0.149
Length of hospital stay (days)	3.79 ± 3.40	5.40 ± 6.58	0.813	4.25 ± 4.73	9.50 ± 10.61	0.448	4.15 ± 4.20	10.50 ± 13.44	0.726
Blood transfusion (units)	(n = 11) 2.36 ± 0.81	(n = 5) 5.20 ± 5.17	0.715	2.13 ± 0.81	10.50 ± 3.54	0.016*	3.18 ± 2.98	1.0 ± 0.0	0.121
Systolic blood pressure (mmHg)	72.86 ± 28.67	72.0 ± 44.38	0.961	75.0 ± 34.41	75.0 ± 7.07	1	71.50 ± 31.67	110.0 ± 28.28	0.115
Pulse (beat/min)	110.36 ± 23.41	110.0 ± 14.14	0.975	109.25 ± 20.92	110.0 ± 14.14	0.961	110.75 ± 20.54	95.0 ± 7.07	0.303
Respiratory rate	30.93 ± 5.33	21.40 ± 9.21	0.011*	28.35 ± 9.07	25.0 ± 0.0	0.615	28.75 ± 7.55	21.0 ± 19.80	0.678
GCS	13.07 ± 3.34	13.40 ± 1.82	0.839	13.10 ± 3.16	13.0 ± 1.41	0.966	13.25 ± 2.92	11.50 ± 4.95	0.448
ISS	11.07 ± 2.97	16.40 ± 8.29	0.227	11.55 ± 3.30	24.0 ± 7.07	<0.001*	12.30 ± 5.16	16.50 ± 0.71	0.274
TRISS	0.92 ± 0.13	0.94 ± 0.08	0.778	0.94 ± 0.11	0.86 ± 0.10	0.372	0.93 ± 0.11	0.99 ± 0.0	0.467
Time from admission to operating room (min)	46.43 ± 26.27	64.0 ± 66.56	0.715	197.50 ± 632.69	25.0 ± 7.07	0.111	50.0 ± 38.56	1500.0 ± 1951.61	0.029*
Chest tube thoracostomy (n)							4	2	0.041*
Preoperative FAST							19	1	0.044*
Preoperative CT							3	2	0.043*

*Significant.

5. Conclusion

The most common clinical presentation in trauma patient was shock. Penetrating trauma patients, especially those with stab injury, were usually hemo-dynamically unstable on arrival to the hospital. The most common two indications for ET were shock and pericardial tamponade. Left anterior thoracotomy was the most common approach used in ET. The most common intra-operative findings in chest trauma were pulmonary injuries, followed by cardiac injuries. The overall mortality was 9.1%. Factors affecting mortality rate in ET were ISS and the amount of blood transfusion.

Conflict of interest

There is no conflict of interest.

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