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Analysis of patients requiring urgent thoracotomy

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Abstract. – OBJECTIVE: We aimed at investigating the effects of clinical data, urgent thoracotomy (UT) indications and results on prognosis and mortality in traumatic and non-traumatic patients who were and underwent UT in the operating room.

PATIENTS AND METHODS: Patients (17-90 years old) who were admitted to the Emergency Department of Afyonkarahisar State Hospital between 01.01.2012 and 31.06.2020 with traumatic and non-traumatic reasons requiring UT were retrospectively conducted from the archive. The patients' age, gender, complaints during admission, trauma classification, reports of thorax images, injury sites accompanying trauma, hospitalization and mortality rates were examined. IBM SPSS 22.0 program was used to compare all the data obtained.

RESULTS: During the 90-month study period, a total of 40 patients who were admitted for traumatic and non-traumatic reasons were applied UT. The mean age of all patients (77.5% male, 22.5% female) was 33.35±14.1 years. There were 55% penetrating injuries, 32.5% blunt injuries and 12.5% non-traumatic causes. Indications for UT in the study were; massive hemothorax (25%), diaphragmatic rupture (22.5 %), hypovolemic shock (25%), heart or great vessel injuries (15%), massive air leak despite thoracostomy (10%), rupture of the pulmonary hydatid cyst into the bronchus and accompanying hemoptysis (2.5%). The time to surgical procedure in patients who underwent thoracotomy was shorter in patients with death. Mean time to thoracotomy was 4.5±6.5 hours. Mortality of UT was 20% with survival of 80%.

CONCLUSIONS: In the context of indications, urgent thoracotomy reduces mortality. The cooperation between the emergency physician and the thoracic surgeon is important during the decision phase.

Key Words:
Urgent thoracotomy, Emergency department, Massive hemothorax.

Introduction

An urgent thoracotomy (UT) is defined as surgical thoracic intervention performed in the operating room environment within the first 48 hours of the patient's stay in the Intensive Care Unit (ICU)[1]. As a thoracic surgery procedure, the open incision method is still frequently used[2]. Thoracic traumas are injuries that need to be diagnosed and treated quickly and accurately. Even if less than half of thoracic traumas require surgical revision, thoracic injuries can have serious consequences[3-5]. In cases where thoracic injuries cannot be treated with chest drainage alone or when a more serious injury is detected in the chest drain, surgical exploration is required[3]. According to the Advanced Trauma Life Support (ATLS) guideline, emergency thoracic surgery is recommended in chest injuries, in the first 2-4 hours after chest tube insertion, in the event of blood loss of more than 1,500 mL or more than 200 mL/h. However, UT is also recommended in cases of endobronchial blood loss or tracheobronchial injuries and heart or great vessel injuries[3,6]. Hemothorax and pneumohemothorax are conditions that can be encountered due to traumatic or non-traumatic reasons[7,8]. UT indications in spontaneous pneumohemothorax cases; if ongoing bleeding more than 1,500 mL or more than 200 mL / hour when a chest drain is inserted, if there is hypovolemic shock, if there is a permanent air leak or if the lungs are not expanded, if there is pachypleuritis, recurrent pneumothorax or empyema with hematoma[9].

The aim of this study was to investigate the effects of clinical data, UT indications and results on prognosis and mortality in traumatic and non-traumatic patients who were admitted to the Emergency Department (ED) and underwent UT in the operating room.

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Patients and Methods

Patients (17-90 years old) who were admitted to the ED of Afyonkarahisar State Hospital between 01.01.2012-31.06.2020 with traumatic and non-traumatic reasons requiring UT were retrospectively screened from the archive. The study was approved by the Ethics Committee of Afyonkarahisar Health Sciences University Clinical Research (Date: 11/09/2020, Decision No: 2020/401). The patients' age, gender, complaints during admission, trauma classification (traffic accident, fall, gunshot wounds, sharp and penetrating object injuries), reports of thorax images, injury sites accompanying trauma, hospitalization and mortality rates were examined.

Statistical Analysis

Statistical analysis of the study was performed using SPSS version 22.0. (IBM; Armonk, NY, USA). In the study, demographic data of the patients, percentage, frequency, mean, standard deviation, median, minimum and maximum values of the emergency patients were shown. The distribution of the data was determined by Kolmogorov-Smirnov test, and evenly distributed data were evaluated using Student's T test among groups, and non-uniform data was evaluated using Mann-Whitney U test. $p<0.05$ was considered statistically significant. Univariate analysis was performed using the χ^2 test for categorical data.

Results

During the 90-month study period, a total of 40 patients who were admitted to the ED for traumatic and non-traumatic reasons underwent UT. The mean age of all patients (77.5% male, 22.5% female) was 33.35±14.1 years (ranged from 17 to 75 years). There were 22 (55%) penetrating injuries, 13 (32.5%) blunt injuries and 5 (12.5%) non-traumatic causes. Blunt injury causes were traffic accidents (n=4), fall from heights (n=8), and crush injuries (n=1). Sharp and penetrating object injuries (n=15) and gunshot wounds (n=7) were identified as the causes of penetrating injuries. However, non-traumatic causes were pulmonary hydatid cyst (n=2) and giant bullae (n=3), (Figure 1).

Indications for UT in 40 patients were massive hemothorax (10; 25%), diaphragmatic rupture (9; 22.5 %), hypovolemic shock (10; 25%), heart or great vessel injuries (6; 15%), massive air leak despite thoracostomy (4; 10%), rupture of the pulmonary hydatid cyst into the bronchus and accompanying hemoptysis (1; 2.5%). Erythrocyte suspension transfusion was performed in 67.5% of the patients and fresh frozen plasma transfusion was performed in 45%.

Operative approaches included anterolateral thoracotomy (n=3), posterolateral thoracotomy (n=34) and mini-thoracotomy (n=3) (Figure 2). Pulmonary parenchyma injuries were the

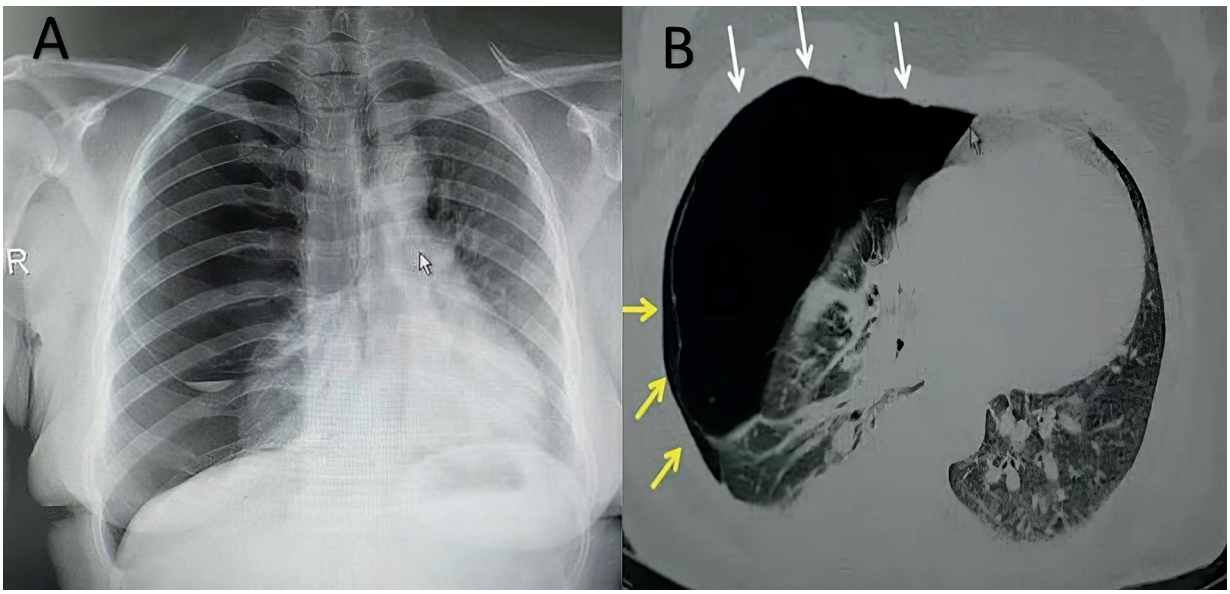

Figure 1. Posteroanterior chest roentgenogram **(A)** shows giant radiolucent bullae formation on right lung. Also, giant bullae formation (white arrows) and adjacent minimal pneumothorax (yellow arrows) are seen in the axial thorax CT **(B)** image taken in the mediastinal window.

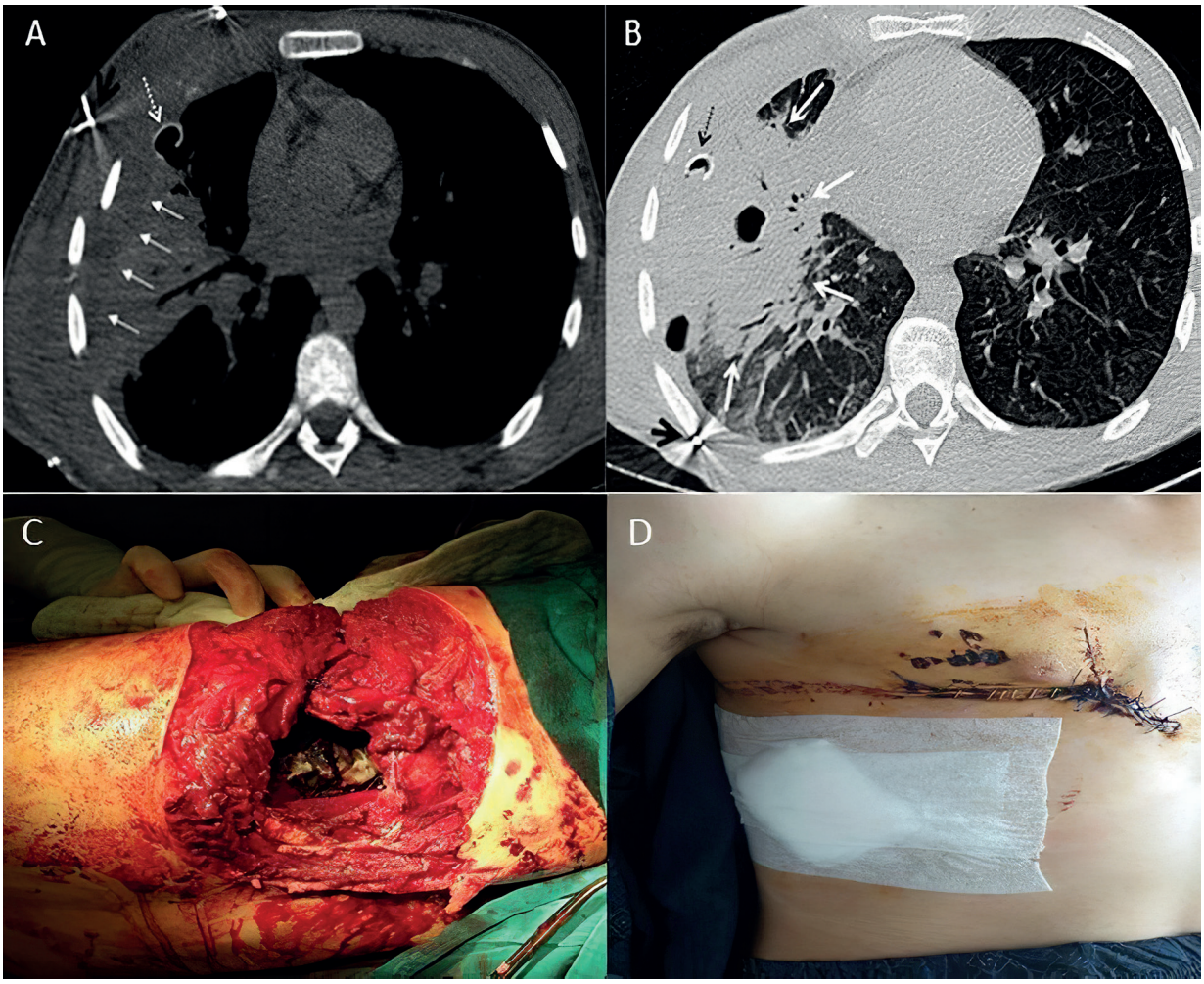

Figure 2. 17-year-old male patient. Axial mediastinal **(A)** and parenchymal **(B)** window of thorax CT images reveal minimal hemothorax (thin white arrows), large area of contusion in the right lung (thick white arrows), thoracostomy tube (dashed arrow), bullet fragment (black arrow). Lung hemorrhage control, lobectomy not performed, no abdominal cardiac and diaphragm injury, skin flap application by sliding the latissimus dorsi defect area, posterolateral thoracotomy photograph **(C)**. The area with the bandage where the chest tube was removed **(D)**.

most common intraoperative findings in trauma groups (Table I). It was determined that cystotomy with capitonnage technique was applied to 2 patients due to pulmonary hydatid cyst and bullae excision was performed in 3 patients due to giant bullae. It was found that only 2 of 55 patients who had pulmonary hydatid cyst operation in the study date range underwent UT. The mean duration of hospitalization in the ICU was determined to be 3.9 ± 2.8 days. After thoracotomy only 2 patients were referred to other hospitals.

14 patients were intubated in the ED and cardiopulmonary resuscitation was required in 3 patients. Three of the patients required internal cardiac massage, but 2 of these patients were died on the same day and the other patient on the 4th day. It was determined that 6 patients died in the first 48 hours. Mortality of UT was 20% with survival of 80 %. Half of the patients who died were due to penetrating traumas and the other half to blunt traumas (Table II).

When the patients with chest tube output amount of more than 1.500 mL and less than 1.500 mL in the first 2-4 hours before thoracotomy were evaluated, it was found that the amount of tube output had no effect on survival between the groups (p=0.388).

Mean time to thoracotomy was 4.5±6.5 hours. The mean time from the time of admission to the ED to thoracotomy of the surviving patients was 4.9±6.9 and the median value was 1.5 hours

Table I. Preoperative and intra-operative thoracic findings.

Thoracic events	Blunt Injury	Penetrating Injury	Non-traumatic causes
Pre-operation			
Right hemothorax	7	10	1
Left hemothorax	4	11	-
Right pneumothorax	5	4	3
Left pneumothorax	4	2	1
Rib fractures	8	3	-
Pulmonary contusion	4	1	-
Also found in operation			
Right pulmonary parenchymal injuries	6	7	-
Left pulmonary parenchymal injuries	4	11	-
Intercostal artery injury	-	2	-
Aorta/great vessel injury	1	2	-
Cardiac	1	2	-

(min=5 minutes, max=22.3 hours). In the patients who died, the mean time from the time of admission to the ED to thoracotomy was 1.8±2.1 and the median value was 52 minutes (min=35 minutes, max=6.75 hours).

However, it was found that the time to surgical procedure in patients who underwent thoracotomy was longer in survivors and although this period was shorter in patients with death, there was no statistically significant difference in terms of duration and survival (p=0.325)

Discussion

Among the causes of trauma, fall from heights were the most frequent cause of blunt chest injuries (8 patients; 61.5%), while sharp and penetrating object injuries was the commonest (15 patients; 68.2%) cause of penetrating thoracic traumas. While gunshot injuries were the most common group requiring UT among penetrating injuries in the study performed, penetrating stab injuries were more common in this study[10]. Similar to the study conducted, in this study, pulmonary parenchymal injuries were determined as the most common intraoperative findings in trauma groups[10].

In a study in which 157 patients underwent UT for thoracic hemorrhage, it was reported that mortality increased as total chest blood loss increased. However, in this study, it was found that the amount of chest tube output did not affect survival among the groups with chest blood loss greater than 1,500 mL and less than 1,500 mL[1]. And also, as seen in the Table II, similar to the study conducted by Ahmad et al[10], the amount of chest tube output in the first 2-4 hours was more than 1,500 mL and it was found that this amount alone did not affect survival. We think that not only hourly chest tube output follow-up, but also technical issues related to chest tube such as correct placement of the chest tube, detection of leakage in un-

Table II. Causes of death in eight patients underwent urgent thoracotomy.

Cause of death (n = 8)	Form of trauma	N (%)
Massive hemothorax and left sided bi lobe pulmonary contusion with hypovolemic shock	Blunt	1 (12.5%)
Right lower lobe pulmonary contusion with liver laceration, thoracic vertebral fracture and cerebral edema	Blunt	1 (12.5%)
Massive hemothorax with splenic laceration and diaphragmatic rupture	Blunt	1 (12.5%)
Right middle lobe pulmonary contusion with thoracic vertebral fracture	Blunt	1 (12.5%)
Massive hemothorax with diaphragmatic, liver rupture and terminal ileum perforation	Penetrating	1 (12.5%)
Massive hemothorax with right atrium injury and diaphragmatic rupture	Penetrating	1 (12.5%)
Right upper lobe pulmonary contusion with right subclavian vein laceration	Penetrating	1 (12.5%)
Massive hemothorax	Penetrating	1 (12.5%)
Total		**8 (100%)**

derwater seal chest drainage, occlusion of the tube, insufficient evacuation of the hemothorax should be considered.

In stable trauma patients with thoracic injuries, proceeding directly to Video-assisted thoracic surgery (VATS) to identify injuries even before placement of a chest tube has been shown to be safe, VATS should be done in the first 3 days to 7 days of hospitalization to decrease the risk of infection and conversion to thoracotomy. Additionally, a systematic review in 2012 proposed that early VATS was an effective treatment for retained hemothorax or other complications of chest trauma. VATS contraindications include hemodynamic instability, massive hemothorax, presence of unspecified or competing injuries, any indication for laparotomy, suspected cardiac injury, and the inability to tolerate single lung ventilation or lateral decubitus position[11-13]. In this study, the recommended volume of 1,500 mL as an indicator for urgent thoracotomy has been validated. We think that the lack of a significant relationship between the amount of chest tube output and survival is due to the presence of accompanying trauma, chronic disease and the patient's hemodynamic status.

Great vessel injuries are after penetrating chest injury with an incidence of approximately 4%[14,15]. In this study, 15% of the patients had heart or great vessel injuries and we can attribute the high incidence of it to the development of pre-hospital healthcare services and the increase in trauma centers.

Although the selection of the appropriate chest incision according to chest exploration indications is critical, when the diagnosis is uncertain, posterior lateral thoracotomy is the preferred incision along the fifth intercostal space on the trauma side[14]. Posterolateral thoracotomy was performed in 85% of patients in this study.

Delaying thoracotomy in patients with a blunt injury mechanism is associated with an increased risk for morbidity and mortality. 50% of deaths in blunt and penetrating injuries occur due to thoracic hemorrhage[1]. In this study, 25% patients had massive hemothorax. It was found that 62.5% of the patients who died had massive hemothorax and 40% were due to blunt trauma. With this study, the survival of 69.2% of patients with blunt trauma shows that thoracotomy should not be delayed in blunt trauma.

In the studies performed, spontaneous hemopneumothorax patients underwent urgent operation for permanent bleeding, shock and hemostasis would be required[16,17]. In the case reports, it is emphasized that thoracotomy was performed for the giant bullae causing mediastinal deviation and the importance of radiological imaging in determining the operation before performing tube thoracostomy to the patients[18,19]. The giant bullae leads acute respiratory failure by causing flattening of the diaphragm contour, mediastinal shift and total atelectasis of the intact lung tissue on the same side[18]. Similar to the studies, after radiological imaging 5 patients due to non-traumatic causes were underwent UT in this study. It was determined that patients with giant bullae had symptoms of acute respiratory failure. The pulmonary hydatid cyst cases underwent thoracotomy urgently due to a massive air leak, despite thoracostomy.

In a study, mean time to thoracotomy was 3.16 ± 3.45 h[20]. Their results are similar to ours, but their study consisted penetrating injuries.

Conclusions

A rapid assessment by the emergency physician and / or thoracic surgeon is required to decide whether UT is required. In traumatic or non-traumatic patients, timely operation decision is of great importance in order to reduce mortality and morbidity.

Conflict of Interest
The Authors declare that they have no conflict of interests.

Financial Disclosure
The authors received no financial support for the research and/or authorship of this article.

Ethics
This study was approved by the Ethical Committee of Afyonkarahisar Health Sciences University, Faculty of Medicine (2020/401).

Authors' Contribution
Ertekin A designed this study. Ertekin A and Öcalan D searched for articles. Öcalan D performed statistical analyses. Öcalan K and Gencer A performed data extraction. All authors wrote this article. Ertekin A made academic language and grammer editing..

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