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Title: An Analysis of Patients who Underwent Tube Thoracostomy in the Emergency Department: A Single Center Study

Short title: Tube Thoracostomy in the Emergency Department

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Abstract

OBJECTIVES: The aim of this study was to determine the demographic and clinical characteristics of patients who underwent tube thoracostomy in the emergency department (ED). The secondary aim of the study was to evaluate parameters such as the diagnosis for which the patients underwent tube thoracostomy, the imaging techniques used during diagnosis, and complications related to the procedure.

MATERIALS AND METHODS: This prospective study was conducted in the ED between June 1, 2015 and May 31, 2016. The study included 125 patients aged >18 years, of both sexes, who presented to the ED during this period and who underwent tube thoracostomy.
RESULTS: The patients comprised 91 (73%) males and 34 (27%) females. Of the 125 patients, 21 (17%) presented directly to the ED, 8 (6%) were referred from a polyclinic, 82 (66%) were brought by ambulance, and 14 (11%) were referred from another center. Reasons for presentation were traumatic in 64 (51%) and non-traumatic in 61 (49%) patients. The leading diagnosis was pneumothorax in 98 (78.4%) cases. The procedure of tube thoracostomy was performed by an emergency medicine (EM) resident for 26 (21%) cases and by a thoracic surgery resident for 99 (79%) cases. Complications were observed at the rate of 3.8% in the procedures performed by the EM residents and at 4% in those performed by the thoracic surgery residents. The mean follow-up time of the patients with tube thoracostomy was 7.5±4.4 days.
CONCLUSION: In intensive trauma centers, in particular, and in centers where procedures such as central venous catheterization and diagnostic thoracentesis are frequently performed, it would be useful for EM physicians to undergo training in performing tube thoracostomy to a level where they are able to intervene in an emergency situation such as traumatic or iatrogenic pneumothorax.

KEYWORDS: Emergency department, pneumothorax, tube thoracostomy

INTRODUCTION

Tube thoracostomy (TT) is a surgical method that is commonly used by thoracic surgeons. Because it is a life-saving procedure, general surgeons, intensive care unit (ICU) physicians, and emergency department (ED) physicians may be required to perform it [1]. TT is defined as a procedure in which a drainage tube is placed to remove air, fluid, blood, pus, or bile from the pleural cavity. The procedure is usually performed from the 4th or 5th intercostal space over the anterior or mid axillary line [2].

TT was first described by Hippocrates. In 1876, Hewett was the first to use a completely closed intercostal drainage system [2]. In the 1950s, Maloney and Gray introduced the terms “tube thoracostomy,” “closed thoracostomy,” and “closed drainage” for chest trauma patients [3]. Indications for TT are pneumothorax (PTX), hemothorax, pleural effusion, chylothorax, and bronchopleural fistula [4].

The aim of this study was to determine the demographic and clinical characteristics of patients who underwent TT in the ED. Parameters such as the diagnosis for which TT was performed, the imaging techniques used during diagnosis, and complications related to the procedure were evaluated.

MATERIALS AND METHODS

This prospective study was conducted with patients aged >18 years who underwent TT in the ED between June 1, 2015 and May 31, 2016, at our emergency medicine (EM) department

after obtaining approval from ethics committee of Erciyes University Clinical Research (Date: May 22, 2015; number: 2015/264). Informed consent was obtained from all the patients.

The following criteria for each patient were recorded: name, age, and sex, the diagnosis for which TT was performed, the etiology of the diagnosis, whether or not there was any other system pathology in addition to the main diagnosis, the type of surgeon performing the TT (thoracic surgery resident or EM resident), whether or not complications developed after the procedure, and if so, the nature of the complications. Finally, the ED outcome of the patient and duration of follow-up were recorded.

The study included 125 patients who underwent TT in the ED. Patients aged <18 years and those who had undergone TT at another center and were then transferred were excluded from the study.

Statistical Analysis

Data obtained in the study were analyzed using Statistical Package for the Social Sciences version 15.0 for Windows software (SPSS Inc.; Chicago, IL, USA). Data were stated as number (n) and percentage (%), and numerical variables were stated as the arithmetic mean ± standard deviation. The Chi-square test was used for the analysis of categorical variables.

RESULTS

The 125 patients included in the study comprised 91 (73%) males and 34 (27%) females, with a mean age of 45.4±21.2 years; 64 (51%) cases presented for traumatic reasons and 61 (49%) for non-traumatic reasons.

When the means of arriving at the ED were evaluated, it was observed that 21 (17%) patients presented directly to the ED, 8 (6%) were referred from a polyclinic, 82 (66%) were brought by ambulance, and 14 (11%) were referred from another center.

Prior to TT, the imaging techniques used for the patients who underwent TT for any reason in the ED included posterior-anterior pulmonary radiography (21.6%), thoracic computed tomography (CT) (56.8%), and both imaging methods (20.8%). Imaging was not performed before the procedure in 1 patient who was believed to have tension pneumothorax (PTX). PTX was diagnosed in 78.4%, pleural fluid in 19.2%, and hemothorax in 24.8% patients. In 4 patients, PTX and pleural fluid were observed and in 24 patients, PTX and hemothorax were observed.

Of the patients with PTX, 59.1% had PTX due to trauma. Isolated PTX was observed in 51.6% patients and hemopneumothorax in 37.5%. In 95.8% patients diagnosed with pleural fluid, TT was employed because of non-traumatic reasons. All hemothorax cases were associated with traumatic etiology. Tension PTX was considered in 1 patient.

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Of the patients who underwent TT because of spontaneous PTX, 88.4% were males and 11.6% were females. The difference in occurrence of PTX between the sexes was statistically significant (p=0.003). The mean age of patients with spontaneous PTX was 35.6±19.2 years (range, 18-74 years).

Of the patients who underwent TT because of pleural fluid, 75% were observed to be associated with malignancy, 20.8% with pneumonia, and 4.2% with trauma. In patients presenting with trauma, the most frequently observed additional thoracic pathology associated with trauma was rib fracture in 35.2%, followed by pulmonary contusion in 20% (Table 1).

The most frequent concomitant systemic pathologies other than thoracic in the trauma patients were observed in the central nervous system (CNS) (37%), musculoskeletal system (25%), and gastrointestinal system (GIS) (15.6%) cases (Table 2). The TT was performed by a thoracic surgery resident in 79.2% cases and by an EM resident in 20.8%.

The complication rate following the procedure performed by the thoracic surgeons was 4%, the most common complication being diaphragm laceration (Table 3). The complication rate following the procedure performed by the EM residents was 3.8%. The difference between the two types of surgeons with respect to the outcome of the procedure was not statistically significant (p=0.964).
Of the total patients, 58.4% were admitted to ICUs and 26.4% to wards; 11.2% of the patients were transferred to ICUs of other institutions and 4% were exitus in the ED. The mean follow-up period of the patients who underwent TT was 7.5±4.4 days (range, 0-27 days).

DISCUSSION

When the demographic characteristics of the patients included in the study were evaluated, it was observed that 91 (72.8%) of the patients were males and 34 (27.2%) were females and the mean age of the whole sample was 45.4 years. In a study by Edaigbini et al. [5], 63.5% of the patients were males and 36.5% were females with a mean age of 34.85 years. In a study on PTX, Inci et al. [6] reported that 82.2% of their cases were males and 17.8% were females. In a study by Ball et al. [7], of the 61 patients who underwent TT, 77% were males and 23% females, whereas Menger et al. [8] reported 73.4% males and 26.6% females in a similar study. Though the current study evaluated patients who underwent TT for more than one indication, the age and sex of the patients were found to be similar to that mentioned in previous reports. When the means of arriving at the ED was evaluated, it was observed that 82 (66%) were brought by ambulance, 21(17%) presented directly to the ED, 14 (11%) were referred from another center, and 8 (6%) were referred from a polyclinic. Of the patients referred from polyclinics, iatrogenic PTX was determined in 87.5% and these were observed secondary to lung biopsy. From the literature, no study with information on the means through which the patients presented to the ED was found. Thus, the current study is of value with respect to TT applications in the ED and the diagnostic spectrum.

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In the current study, traumatic causes were present in 64 (51.2%) cases and non-traumatic in 61 (48.8%) cases. In the literature, it is seen that PTX cases or pleural effusion cases are examined in isolated trauma patients. As the aim of the current study was to examine TT cases in the ED and the patients presenting to the ED were in a very broad diagnostic spectrum, no comparison was performed with studies examining TT employed for a single diagnosis.

When the imaging techniques employed for diagnostic purposes were examined, it was found that posterior-anterior pulmonary radiography was performed for 27 (21.6%) patients, thoracic CT for 71 (56.8%), and both imaging methods were used for 26 (20.8%). In study by Ball et al. [9], 1,121 patients were examined; PA pulmonary radiography was used for 87% whereas PA pulmonary radiography and CT were used for 13% patients. Ince et al. [6] examined PTX cases and reported that PA pulmonary radiography was employed to 64.3% patients, thoracic CT to 8.5%, and both imaging methods were used in 27.2%. In a study of patients with blunt chest trauma, Kaya et al. [10] reported the use of PA pulmonary radiography in 42.4% patients, and PA pulmonary radiography together with thoracic CT in 56.6%. The current study showed some differences from the literature regarding the use of imaging techniques.

The reason for the greater rate of use of CT for patients in the current study can be attributed to the reason that patients presented to the ED because of multitrauma; CT was performed to confirm the presence of pleural fluid observed on PA pulmonary radiograph obtained before TT in non-trauma patients; and CT was considered for further testing of patients in whom PTX was suspected but not observed on PA pulmonary radiograph.

The diagnoses of the patients were made using the imaging techniques. According to this, PTX was diagnosed in 98 (78.4%) patients, hemothorax in 31 (24.8%), and pleural fluid in 24 (19.2%). In a study of trauma patients by Ball et al. [7], TT was employed because of PTX in 62%, hemopneumothorax in 30%, and hemothorax in 8% patients. A total of 1,042 patients were analyzed by Kong et al. [11], and TT was determined to have been performed because of a diagnosis of PTX in 37%, hemoneumothorax in 33%, hemothorax in 30%, and tension PTX in 8% patients. In another study by Kong et al. [12], PTX was diagnosed in 72%, hemopneumothorax in 15%, hemothorax in 11%, and tension PTX in 2% patients. In a study by Afshar et al. [13], PTX was diagnosed in 37%, hemothorax in 35%, and hemopneumothorax in 26.3% patients. The findings of the current study regarding the diagnoses showed great similarity to those of previous studies.

The patients of the current study who underwent TT because of PTX were sub categorized further. The primary cause in these patients was trauma; PTX was traumatic in 58 (59.2%) of 98 cases, spontaneous in 26 (26.5%), and iatrogenic PTX in 13 (13.3%). In 1 (1.0%) case, tension PTX was considered. In study by Ince et al. [6] which examined PTX cases, 66.2% were observed to be spontaneous PTX, 24.8% traumatic, and 9% iatrogenic. Cho et al. [14] reported non-traumatic PTX cases to be 96% spontaneous PTX and 4% iatrogenic PTX. The hospital where the current study was conducted serves as a regional trauma center. Therefore, this can

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be considered to be the reason for the higher rate of occurrence of traumatic PTX cases than non-traumatic PTX cases. In addition, majority of the spontaneous PTX cases were diagnosed in polyclinics that were associated with underlying pulmonary diseases, which were then followed up in the relevant polyclinic. This can be considered the reason for the low rate of the spontaneous PTX cases determined in the ED. Therefore, the findings of the spontaneous PTX cases in the current study are proportionally lower in comparison with the literature.
The 26 patients of the current study with spontaneous PTX diagnosis comprised 23 (88.4%) males and 3 (11.6%) females with a mean age of 35.6±19.2 years (range, 18-74 years). In a study of spontaneous PTX by Olesen et al. [15], 83% were males and 17% females with a mean age of 25.2±7.1 years. Yang et al. [16] reported these rates as 84% males and 16% females with a mean age of 22.9±8.1 years. While the gender rates in this study were similar to the literature, the mean age was a little higher than the literature.The reason for the high mean age could be the inclusion of secondary spontaneous PTX cases in the current study.

When the additional thoracic pathologies and the additional systemic pathologies were evaluated in the current study, a combination of several pathologies was commonly observed. The most frequently observed pathology was rib fracture in 44 (35.2%) patients. Pulmonary contusion was determined in 26 (20%) patients, clavicle fracture in 7 (5.6%), scapula fracture in 6 (4.8%), sternum fracture in 3 (2.4%), and pneumomediastinum in 1 (0.8%) (thorax pathologies were observed in traumatic patients). Systemic pathologies, those not in the thorax, were observed in the CNS in 24 (19.2%) cases, the musculoskeletal system in 16 (12.8%), the GIS in 10 (0.8%), the cardiovascular system in 7 (5.6%), and the genitourinary system (GUS) in 2 (1.6%). In 1 patient, sepsis was determined as an additional systemic pathology. In a study by Leblebici et al. [17], thoracic pathologies in patients with chest trauma were reported as rib fracture in 29.5%, pulmonary contusion in 10.9%, clavicle fracture in 2.7%, scapula fracture in 2.0%, and sternum fracture in 0.7%. In the same study, additional systemic pathologies were as follows: GIS (29.3%), CNS (25.2%), and musculoskeletal system (21.8%).

In patients examined in a study by İmamoğlu et al. [18], rib fracture was observed in 36.4%, pulmonary contusion in 12.7%, clavicle fracture in 5.5%, sternum fracture in 3.6%, and scapula fracture in 2.7%. Demirhan et al. [19] determined rib fractures in 30% of the thoracic trauma patients, pulmonary contusion in 2.4%, clavicle fracture in 1%, and sternum fracture in 0.9%. Afacan et al. [20] were reported other systemic pathologies in thoracic trauma patients as 46% musculoskeletal system, 21.1% CNS, 8.9% GIS, and 2.5% GUS. The rate of occurrence of rib fracture as additional thoracic pathology in the current study was similar to the rates previously reported in the literature, but the rates of the extra-thoracic pathologies did not show a similarity. This can be due to the inclusion of multitrauma patients in the current study, whereas most of the other studies only examined thoracic trauma. In several studies in Turkey, the most common concomitant systemic pathologies in thoracic trauma patients have been observed to be in the musculoskeletal system and CNS. Similarly, in the current study, CNS and musculoskeletal system pathologies were determined to be the most common concomitant pathologies in trauma patients.

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In 26 (20.8%) patients in the current study, TT was performed by an EM resident and in 99 (79.2%) cases by a thoracic surgery resident. In a study by Duong et al. [21], it was reported that TT was performed by ED physicians in 74.3% and by surgeons in 14.9%, and for the remaining 10.8%, the unit performing TT was not specified. In a study by Ball et al. [7], TT was performed by a general surgeon in 36.8% of cases, by an EM specialist in 26.3%, and by various other branch specialists in 36.9%. A study by Deneuville [22] reported that the procedure was performed by thoracic surgeons in 68.8% and by ED and ICU physicians in 31.2%. In a study conducted in the ED by Sethuraman et al. [23], the procedure was performed by EM residents in 74.3% and by surgeons in 14.9%. In the literature, it was seen that the rate of procedures applied by ED physicians was higher in some studies and the rate applied by surgical branches was higher in some studies. In the current study, the rate of TT performed by ED physicians was observed to be slightly lower than the rates reported in the literature. However, as there is no other study in Turkey that has examined patients who underwent TT in the ED, the findings are important with respect to creating national data.

Complications were observed in 5 (4%) of the 125 patients after TT was performed in the ED. These complications included diaphragm laceration in 2 (1.6%), tube malposition in 1 (0.8%), and advancement of the tube subcutaneously in 1 (0.8%). As persistent air leakage was observed after TT in 1 (0.8%) patient, further treatment was given. Of the 5 patients with complications, TT was performed by an EM resident in 1 case and by a thoracic surgery resident in 4 cases.

In a study by Deneuville [22], complication rates according to the type of surgeon performing TT were observed to be 6.8% in thoracic surgery and 65% in the other group which included ED and ICU physicians. Martin et al. [24] reported the complication rate as 6% after TT was performed by surgeons and 13% after the procedure was performed by ED physicians. Duong et al. [21] found the complication rate after TT to be 37.2%. Of note, 20.6% of the complications were reported to be various tube malpositionings, 1.1% were intercostal vessel injuries, 1.1% were retroperitoneal placement, and other complications were in the category of late complications. Ball et al. [7] reported a complication rate of 22.4% in trauma patients who underwent TT. It was noted that 11.8% of the complications were due to malposition and 7.9% were interventional complications (intercostal artery injury and pulmonary artery injury).

A complication rate of 16.8% was reported by Edaigbini et al. [5] Complications were as follows: 1.2% malposition, 1.8% removal of the tube from the wrong place, 0.6% tube obstruction, and others were late complications such as empyema and sepsis. The complication rate observed in the current study was extremely low compared to that in the literature. This can be attributed to the study center which is a university hospital where there are specialist EM and thoracic surgery physicians available 24 hours. Moreover, as the hospital is a large trauma center, many TT procedures are performed and therefore the team had sufficient expertise in this field. However, because only the complications developed after TT

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was performed in the ED were evaluated, it was not possible to make a comparison with other studies in the literature with respect to late complications.

When the patients included in this study were examined with respect to hospitalized follow-up and continuation of treatment after the TT procedure, 73 (58.4%) patients were admitted to the ICU, and 33 (26.4%) to clinic wards. As vacant beds could not be found in the hospital for 14 (11.2%) patients, they were transferred to other institutions, and 5 (4.0%) patients were exitus in the ED.

In a study by Çorbacıoğlu et al. [25], 18.1% of patients were admitted to ICU, 34.2% to wards, and the exitus rate was 0.8%. Kong and Clarke [12] reported ICU admittance to be 15% and the mortality rate to be 4%.

When the hospitalization data of the current study patients were examined, the rates of admittance to ICU were found to be higher than those in the literature. The reason for this higher rate of ICU admittance could be the patients requiring admittance after TT because of the presence of comorbidities such as malignancy or the presence of additional pathologies such as multitrauma. The mortality rate in the ED was found to be low compared to that reported in several studies in the literature. This could be due to mortality in critical patients at the scene before being brought to hospital and also it could be due to the necessary treatment being administered rapidly as there is an experienced team on duty for 24 hours a day at the hospital. The mean follow-up period of the patients with TT was 7.5±4.4 days (range, 0-27 days). Ince et al reported that the follow-up period as 5.6 days in patients who underwent TT because of PTX [6]. The data obtained in the current study related to follow-up periods with TT were found to be consistent with that in the literature.

One limitation of this study is that it is single-centered. We believe that better quality studies will be with larger populations and very self-centered.

In conclusion, although TT is a primary procedure routinely employed by thoracic surgeons, it is currently often performed by EM residents and specialists. At intensive trauma centers, in particular, and at centers where procedures such as central venous catheterization and diagnostic Thoracentesis are frequently performed, it would be useful for EM doctors to undergo training in TT to a level where they are able to intervene in an emergency situation such as traumatic or iatrogenic PTX. Although TT seems to be a simple procedure, when it is performed without sufficient experience, knowledge, and skill, severe complications or even death can result. Careful application of the procedure with diligent aftercare will reduce potential complications, shorten the length of hospital stay, and minimize costs.

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Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Erciyes University Clinical Research (Date: May 22, 2015; number: 2015/264).

Informed Consent: Written informed consent was obtained from all patients who participated in this study.

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Table 1. Concomitant thoracic pathologies

Pathology	(n)	(%)
Rib fracture	44	35.2
Pulmonary contusion	25	20
Clavicle fracture	7	5.6
Scapula fracture	6	4.8
Sternum fracture	3	2.4

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Pneumomediastinum	1	0.8
Other	3	2.4

Table 2. Concomitant other system pathologies in traumatic patients

Additional system pathology	(n)	(%)
CNS pathology	24	37.5
Musculoskeletal pathology	16	25.0
GIS pathology	10	15.6
CVS pathology	6	9.4
GUS pathology	1	1.6

CNS: central nervous system; GIS: gastrointestinal system; GUS: genitourinary system; CVS: cardiovascular system

Table 3. Complications that developed after tube thoracostomy

Complication	(n)	(%)
Diaphragm laceration	2	1.6
Tube malposition	1	0.8
Subcutaneous advancement of the tube	1	0.8
Persistent air leakage	1	0.8

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