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TENSION PNEUMOTHORAX MANAGEMENT, RECENT UPDATES, A CASE CONTROL STUDY

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Abstract

Background*:Tension Pneumothorax is considered as the most common and life-threatening clinical condition, which may require emergency treatment in Emergency Medicine Departments.*

Objectives*:We wanted to measure and estimate number of patients admitted to the Emergency Department with pneumothorax.*

Material and Methods:*This case-control study was conducted at king abdulaziz National Guard hospital, KSA of patients treated with the diagnosis of pneumothorax between August 2017 to June 2018. Patient data were collected from hospital analysis system. According to the etiology of the pneumothorax, study groups were arranged like tension pneumothorax and traumatic pneumothorax.*

Results*:79% (n = 106) of patients were male and 17.8% (n = 23) of patients were female and mean age were 31.3 ± 20,2 (Minimum: 1, Maximum: 87). 68.2% (n = 88) of patients were tension pneumothorax (61.36%, n=79 were primary spontaneous pneumothorax) and 31.8% (n = 41) of patients were traumatic pneumothorax (21.95% were iatrogenic pneumothorax). Main complaint is shortness of breath (52.3%, n=67) and 38% (n=49) of patients were smokers. Posteroanterior (PA) Chest X-Ray has been enough for 64.3% (n = 83) of the patients' diagnosis. Tube thoracostomy is applied to 84.5% (n = 109) of patients and surgery is applied to 9.3% (n = 12) of patients and 6.2% (n = 8) of patients were discharged with conservative treatment. tension pneumothorax showed statistically significant high recurrence compared with traumatic pneumothorax (P = 0.007). 4.65% of (n = 6) patients died. The average age of those who died (9.3 ± 19.9), statistically were significantly lower the mean age of living patients (32.4 ± 19.7) (t test, P = 0,006). 83.33% of the patients who died were neonatals and in the 0-1 years age group, and five of these patients were secondary spontaneous pneumothorax, and one of these patients were iatrogenic pneumothorax due to mechanical ventilation.*

Conclusions:*The existing evidence indicates that needle aspiration is at least as safe and effective as tube thoracostomy for management of pneumothorax. Pneumothorax in adults can be treated by tube thoracostomy or surgically. Despite treatment, mortality of secondary and tension pneumothorax in newborns and 0-1 years age group is high.*

Keywords: *Tension, Emergency Medicine, Pneumothorax*

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INTRODUCTION:

Although health care providers utilize classically described signs and symptoms to diagnose tension pneumothorax, available literature sources differ in their descriptions of its clinical manifestations. Moreover, while the clinical manifestations of tension pneumothorax have been suggested to differ among subjects of varying respiratory status, it remains unknown if these differences are supported by clinical evidence.

Tension pneumothorax, often defined as hemodynamic compromise in a patient with an expanding intrapleural air mass [1], is an uncommon yet potentially catastrophic clinical diagnosis most frequently encountered in pre-hospital, Emergency Department, and Intensive Care Unit (ICU) settings [2-7]. Although a valid estimate of the incidence of tension pneumothorax remains to be determined, this condition has been suggested to occur among 5% of major trauma patients managed in the pre-hospital environment and 1% to 3% of adult ICU patients [2,4,7,8]. In one retrospective cohort study, the adjusted risk of death among mechanically ventilated patients was reported to be approximately 38 times higher among those who developed a tension pneumothorax as compared to those who did not [9].

As tension pneumothorax is associated with substantial mortality, the Advanced Trauma Life Support (ATLS®) guidelines recommend that attempts be made to diagnose this condition during the initial minutes of trauma patient assessment [10]. Moreover, possibly because waiting for a chest radiograph has been associated with an increased risk of death among mechanically ventilated patients [11], most authorities recommend emergent treatment with needle or tube thoracostomy before radiographic confirmation when the condition is first suspected [1,7,10,12-16]. Thus, prehospital providers and physicians utilize classically described clinical manifestations to diagnose tension pneumothorax. These have most frequently been reported to include hemodynamic compromise (hypotension or cardiac arrest) in conjunction with signs suggestive of a pneumothorax (hypoxia, respiratory distress, absent unilateral breath sounds on auscultation) and mediastinal shift (tracheal deviation and jugular venous distention) [7,17].

Primary spontaneous

Spontaneous pneumothoraces are divided into two types: primary, which occurs in the absence of known lung disease, and secondary, which occurs in someone with underlying lung disease. Until now the cause of primary spontaneous pneumothorax (PSP)

has not been identified, however; several risk factors have been identified such as; smoking, male sex, and a family history of pneumothorax. Several underlying mechanisms have been observed and are discussed below. Moreover; a PSP tends to occur in a young adult without underlying lung problems. Symptoms such as, chest pain and sometimes mild breathlessness are usually observed. There are several cases where a PSP is a threat for a patient's life, however; several patients may wait several days before seeking medical attention. It has been observed that it is rare for PSPs to cause tension pneumothoraces.

Secondary spontaneous

Secondary spontaneous pneumothorax occurs due to underlying chest diseases. Most commonly they are observed in patients with chronic obstructive pulmonary disease (COPD), which accounts for approximately 70% of cases. Other known lung diseases that may increase the incidence for pneumothorax are; tuberculosis, necrotizing pneumonia, pneumonocystis carini, lung cancer, sarcoma involving the lung, sarcoidosis, endometriosis, cystic fibrosis, acute severe asthma, idiopathic pulmonary fibrosis, Rheumatoid arthritis, ankylosing spondylitis, polymyositis and dermatomyositis, systemic sclerosis, Marfan's syndrome and Ehlers-Danlos syndrome, histiocytosis X and lymphangioleiomyomatosis (LAM). Secondary spontaneous pneumothoraces (SSPs), by definition, occurs in individuals with significant underlying lung disease. The following symptoms are usually observed; hypoxemia and hypercapnia in more severe cases. The sudden onset of breathlessness in patients with known underlying lung diseases such as; COPD, cystic fibrosis, or other serious lung diseases should therefore prompt investigations to identify the possibility of a pneumothorax.

Traumatic pneumothorax

Traumatic pneumothorax occurs when the chest wall is pierced, such as when a stab wound or gunshot wound allows air to enter the pleural space. Traumatic pneumothoraces have been found to occur in up to half of all cases of chest trauma, with only rib fractures being more common in this group. The pneumothorax can be occult in half of these cases, but may enlarge—particularly if mechanical ventilation is required. This type of pneumothorax has also been observed to patients already receiving

mechanical ventilation for some other reason.

METHODS:

This retrospective case-control study was conducted in the patients treated with the diagnosis of pneumothorax in king abdulaziz National Guard hospital, KSA. The average annual number of patient in the hospital is close to each other and between 20000 and 25000. Socio-cultural structure of people who living around of this hospital are similar and middle income levels.

Patients diagnosed with pneumothorax in automation system were screened. All patients with complete recorded data were included to this study. Patients without complete recorded data were excluded. According to the etiology of the pneumothorax, study groups were arranged like spontaneous pneumothorax (PSP and SSP), and traumatic pneumothorax (general trauma-induced pneumothorax and iatrogenic pneumothorax). The pneumothorax ratio of patients calculated according to the size of pneumothorax by PA chest X-ray or thoracic computed tomography (CT) measured according to the American College of Chest Physicians (ACCP) guidelines, were taken as mean, minimum and maximum values. Light index was also used to calculate the diameter of pneumothorax. All analyses were performed with Statistical Package for the Social Sciences (SPSS) for Windows version 15.0, and the significance level adopted as $P < 0.05$. Chi-square test was used to compare groups for categorical variables, and to compare continuous variables the Student t test was used.

RESULTS:

68.2 % (n = 88) of patients were spontaneous pneumothorax (61.36% were PSP) and 31.8% (n = 41) of patients were traumatic pneumothorax (21.95% were iatrogenic pneumothorax). There was no case of tension pneumothorax in all patient groups. 82.2% (n = 106) of patients was male and 17.8% (n = 23) of patients were female and mean age were 31.3 ± 20.2 (Minimum: 1, Maximum: 87). No significant difference was found between the mean age of spontaneous pneumothorax group (30.7 ± 21.0) and traumatic pneumothorax group (32,6 ± 18,7) (P = 0.629). 4.7% (n = 6) of patients were neonatal patients. 83.3% (n = 107) of patients in neonatal group were found to be of secondary spontaneous pneumothorax, and one patient were iatrogenic pneumothorax (due to mechanical ventilation). 12.1% (n = 16) of patients with traumatic pneumothorax were bilateral pneumothorax (three neonates and 0-1 years age group), and 2.27% (n = 3) of patients with spontaneous pneumothorax were bilateral pneumothorax (P = 0.033). Mean age of bilateral pneumothorax patients were 11.1 ± 12.2, mean age of unilateral pneumothorax patients were 32.52 ± 0,0 and the difference was statistically significant (P = 0.006).

Patients with tension pneumothorax were most commonly admitted to Emergency Medicine Departments with the complaint of shortness of breath, and the most common complaint of the patients with a diagnosis of traumatic pneumothorax were stab wounds. The most common cause of traumatic pneumothorax in patients with iatrogenic reasons was application of mechanical ventilation.

38% (n = 49) of patients were smoker and 93.9% (n = 46) of these patients were male. The rate of males who smoke was significantly higher than the rate of females who smoke (P = 0,007). 60.2% (n = 53) of spontaneous pneumothorax patients and 65.9% (n = 27) of traumatic pneumothorax patients were non-smoker.

There were no significant difference between smoking and pneumothorax type (P = 0.072). ACCP guidelines defines the size of pneumothorax as centimeters measured from the cupula to apex of lung according to PA Chest-X-ray or chest CT of patients, the mean of spontaneous pneumothorax were 3.8 ± 2.7 cm and traumatic pneumothorax were 2.2 ± 1.9 cm (P < 0.001). The mean of 32 patients with general trauma which related from traumatic pneumothorax cases were 2.4 ± 2.1 cm, and the mean of the group iatrogenic pneumothorax was found 1.63 ± 1.1 cm (P = 0.396). According to age group, the percentage of spontaneous pneumothorax group were 76%, and traumatic pneumothorax group was calculated as 52%, using Light index which defines the average of diameter of hemithorax as 10 cm.

The tube thoracostomy is applied to the 84.5% (n = 109) of patients in the study group, and 6.2% (n = 8) were followed up tubeless. Surgical procedure performed to the 9.3% (n = 12) of the patients. The average duration of remaining the tube of the 109 patients treated by tube thoracostomy was found 5.6 ± 4.2 days. This duration were 5.8 ± 4.4 in spontaneous pneumothorax group, and 5.2 ± 3.8 days in traumatic pneumothorax group respectively (P = 0.384). Spontaneous pneumothorax recurrence developed in 20% (n = 18) of cases, and 2.4% (n=1) of the patients with traumatic pneumothorax had recurrence (P = 0.007). No cases of iatrogenic pneumothorax were developed recurrence. Recurrence rate of gender was 8.7% in female and

16% in male (P = 0.295).

Six of 129 patients (4.65%) died during follow-up. Four of them were spontaneous pneumothorax group, and two of them were traumatic pneumothorax. Mortality in the patients with bilateral pneumothorax was observed in only one patient and mortality in the patients with unilateral pneumothorax were five (P = 0.289). The mean age of the patients who died were 9.3 ± 19.9, and the mean age of the living patients were 32.4 ± 19.7 (P = 0.006). Five of the six death cases (83.33%) were in neonatal group and 0-1 year's age group.

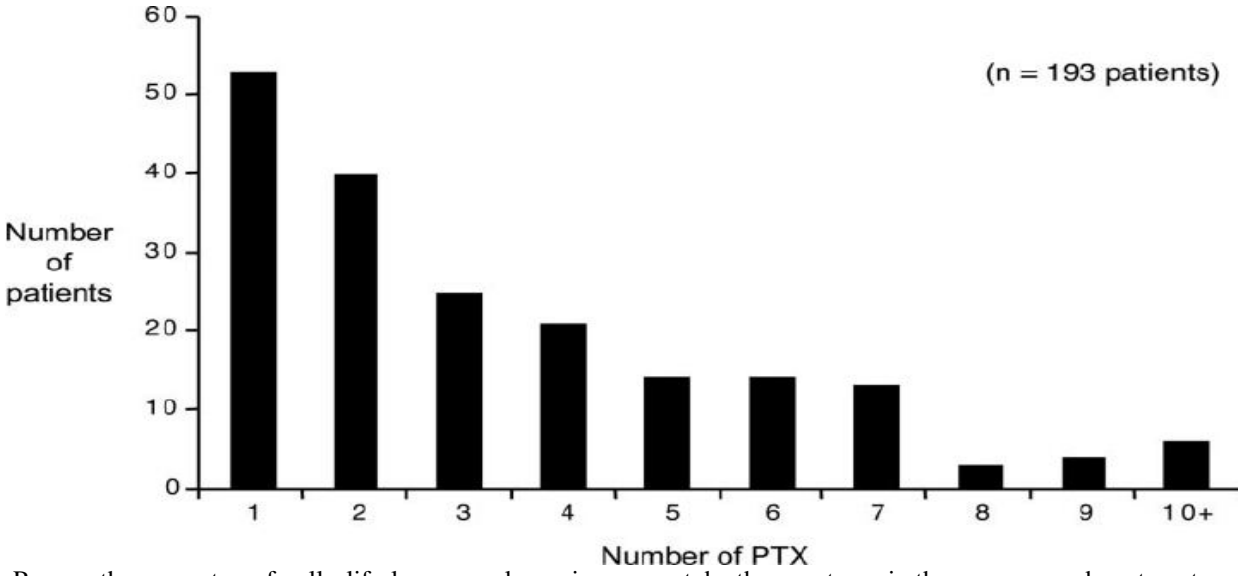
DISCUSSION:

A pneumothorax is a collection of air outside the lung but within the pleural cavity. It occurs when air accumulates between the parietal and visceral pleura inside the chest. The air accumulation can apply pressure on the lung and make it collapse. That is why a pneumothorax is commonly referred to as a "collapsed lung." There are two types of pneumothorax: traumatic and atraumatic. The two subtypes of atraumatic pneumothorax are primary and secondary. A primary spontaneous pneumothorax (PSP) occurs automatically without a known eliciting event, while a secondary spontaneous pneumothorax (SSP) occurs subsequent to an underlying pulmonary disease. A traumatic pneumothorax can be the result of blunt or penetrating trauma. Pneumothoraces can be even further classified as simple, tension, or open. A simple pneumothorax does not shift the mediastinal structures as does a tension pneumothorax. An open pneumothorax also is known as a "sucking" chest wound.

PSP shows variability in incidence because of different causes, and geography. In United States this incidence is 7.4-18/100000 in male, and 1.2-6/100000 in female (7, 8). The reason of PSP occurs in men more than women is the length of thorax is longer in men, apical blebs rupture due to increased pressure in apical region and excess rate of smoking as emphasized in the literatures (9). A 10-year follow up study by Gok M et al. (9) showed that, 12.2% of 164 spontaneous pneumothorax cases were female, and a study by Karasu S et al. (10) showed that 87.3% of 260 spontaneous pneumothorax case was men. Similar to the other studies the male predominance found in our study (82.2%).

The mean ages of the patients were 27.03 ± 8.65 in the study by Karasu et al. (10). Similar to this study, the mean age of the patients was found 31.3 ± 20.2 in our study. Pneumothorax most commonly develops in the neonatal period after first breath in the first period of childhood (3, 11). Term infants and those patients with mechanical ventilation at high risk (12). SSP may develop those patients with asthma, pneumonia, lung disease such as cystic fibrosis (13). In this study 11.62% of patients were in age group one and 4.7% of patients were in neonatal group. Karasu et al. (10) were detected PSP in 91.5% of patients and significant difference was found between these patients and SSP according to age, gender, smoking, duration of treatment, and recurrence. However, in this study 41.9% of the patients were PSP.

In the vast majority of cases of pneumothorax most common symptom is sudden chest pain localized side of pneumothorax in emergency services. The second most common presenting symptom is shortness of breath. In Celik et al. (14) study, the most frequent symtom was shortness of breath (52.1%), and then after chest pain (20.8%), shortness of breath with chest pain (15.6%) and cough (9.3%) followed. Similar to the literature, in this study most frequent symptom is shortness of breath (52.3%), and shortness of breath with chest pain (33.0%). In the study of Imamoglu et al. (15), 110 patients with thoracic trauma were 59.1% blunt trauma, 36.4% penetrating trauma (25.45% stab and 10.90% gunshot wounds), and 4.5% presented with iatrogenic trauma. In this study, similar to Imamoglu et al. study, 26.8% of patients with traumatic pneumothorax are in stab wounds; but different from the literature, 21.95% of patients with traumatic pneumothorax were iatrogenic pneumothorax. Standard X-ray, ultrasound and chest CT can be used for diagnosis. For stable patients PA chest X-ray is standard although its sensitivity is 83% (16). Karasu et al. (10) were used X-Ray in 98% of patients and CT in 2% of patients to diagnose. In this study, PA chest X-Ray is only follow-up for 64.3% of cases with pneumothorax. Ultrasonography was not used in Emergency Department for diagnosis of pneumothorax.



Pneumothorax rate of all life-long smokers is approximately 12%, meanwhile 0.1% for non-smokers (17). In Karasu et al. (10) study smoking rate was 86.9%. In the patients with PSP and SSP rate of smoking was 93.3% and 18.2%, respectively. In this study 39.8% of spontaneous pneumothorax was smokers. 93.9% of smoker patients in the study were male, and it is an indication that men are more smoker than women in our country. In the study of Topdag et al. mean percentage of pneumothorax were 71%. In this study the average size of spontaneous pneumothorax, was significantly higher than the average size of traumatic pneumothorax. According to Light index group percentages of pneumothorax at spontaneous pneumothorax (76%) were higher than traumatic pneumothorax (52%).

In the study on 592 trauma patients of Tekinbas et al. 158 patients were pneumothorax, and 119 patients were hemothorax. 57.26% of the patients were aplied tube thoracostomy, 99 patients were applied surgical treatment, and 190 patients were treated conservatively, and the mean hospital stay was 13.4 days with 6.4% mortality rate. According to study of Wolfman et al. many small occult pneumothoraces can be observed by close follow-up, most of them have low progression risk, and intermediate-size anterior occult pneumothoraces initially managed with observation if positive-pressure ventilation was not anticipated also did not require chest tube placement. Tube thoracostomy is recommended to anterolateral occult pneumothorax cases. In this study, tube thoracostomy is applied to 79.6% of patients and surgery is applied to 9.3% of patients and 6.2% of patients were discharged with conservative treatment. On all patients performed tube thoracostomy in the emergency department.

In the 266 case study of Burcin et al. (14) the mean duration of hospitalization was 9.3 ± 5.3 days and there was significant difference between groups of PSP and SSP and duration of hospitalization. In the 53 case study of Cok et al. (18) the mean duration of hospitalization was 7.7 ± 3.2 days in PSP group and 23.2 ± 18.6 days were in SSP group. In the same study (18), closed intercostal tube drainage applied to 17 patients in primary spontaneous pneumothorax group (mean 7.1 ± 3.3 days) and to 22 patients in SSP group (mean 20 ± 14.3 days). In Topdag et al. study, tube thoracostomy performed to all patients for treatment and the average length of stay of tube determined as 4.6 days. In this study, the average length of stay of tube of 109 patients that tube thoracostomy were performed was 5.6 ± 4.2 days, less than literature.

Recurrence rate of PSP is 32% and of SSP is 43%, if there is not any prevention for recurrence 6.7. Iatrogenic pneumothorax recurrences in the long term are uncommon (19). In Karasu et al. (10) study 8.5% recurrence was observed (7.6% for PSP and 22.7% for SSP). In Kuzucu et al. (20) comparative study with 90 PSP cases between 1999-2004 reported that 17 patients were applied surgery, 24 patients of remaining 73 patients developed recurrence, 15 of the patients with recurrence were applied surgery in second or third episodes, and surgical treatment is best choice for second episode. In this study recurrence was observed in 20% cases of spontaneous pneumothorax and 2.4% cases of traumatic pneumothorax. No recurrence for iatrogenic pneumothorax was found with respect to the

literature. 1.3% of cases of spontaneous pneumothorax has been reported that bilateral and simultaneous spontaneous pneumothorax (21). Eleven countries identified 1988 cases of pneumothorax, and they showed that 1.3% of cases were simultaneous bilateral spontaneous pneumothorax (22). Between 1971-1990 Esther et al. reported 12 case of simultaneous bilateral spontaneous pneumothorax. In this study, bilateral pneumothorax detected in 5.4% of pneumothorax cases and 2.27% of spontaneous pneumothorax cases.

The pressure gradient inside the thorax changes with a pneumothorax. Normally the pressure of the pleural space is negative when compared to atmospheric pressure. When there is communication between the alveoli and the pleural space, air fills this space changing the gradient. A tension pneumothorax occurs when this communication becomes a one-way valve without any outflow from the pleural space. The pressure in the pleural space increases causing hypoxia, mediastinal shift, and can compromise venous return as well. Clinical presentation of a pneumothorax can range anywhere from asymptomatic to chest pain and shortness of breath. A tension pneumothorax can cause severe hypotension (obstructive shock) and even death. Beck's triad describes symptoms commonly associated with tension pneumothorax. The three components of Beck's triad are: distended neck veins, distant heart sounds, and hypotension. Other symptoms include tachypnea, dyspnea, tachycardia, and hypoxia.

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