Frequency of Pneumothorax in patients undergoing large volume Thoracentesis

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Declaration of conflicting interests

The authors declare that there is no conflict of interest.

Abstract

Background: Pleural effusion is the accumulation of abnormal fluid in pleural cavity. Common causes are congestive heart failure, infection and malignancy. The removal of abnormal pleural fluid is known as thoracentesis. Complications of thoracentesis include pneumothorax, re-expansion, pulmonary edema and bleeding. Risk factors include large amount of fluid tape, multiple attempts, underlying lung disease.

Objectives: The present study was conducted to determine the frequency of pneumothorax in patients undergoing large volume thoracocentesis.

Methodology: This cross sectional prospective study was conducted at the Department of medicine, Mufti Mehmood teaching hospital Dera Ismail Khan (D. I. Khan). Study duration was 6 months from 1st September 2019 to 28th February 2020. After informed consent, total of 241 patients of either gender, age between 20-70 years and diagnosed pleural effusion of more than 1000ml on ultrasound were included in the study. Patients with chronic lung disease and those with established pneumothorax were excluded. Demographic details like patient's age and gender were recorded. All Patients undergone blind thoracocentesis by medical consultant followed by a chest radiograph in an erect position. The amount of fluid aspirated and presence or absence of pneumothorax was entered into the proforma.

Results: Out of 241 patients, 46.9% were female and 53.1% male. Mean age of the study population was 38.9 years with SD ± 11.27 and range of 20-69 years. 34 patients (14.1%) developed pneumothorax. Pneumothorax rate was found to be high in those with multiple attempts/needle pass.

Conclusion: The risk of pneumothorax increases with increase in fluid volume aspirated. Risk versus benefit should be evaluated in attempting large fluid aspiration.

Keywords: Pleural Fluid; Thoracentesis; Pneumothorax

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Introduction

Pleural effusion is the accumulation of abnormal fluid in pleural cavity. Most common causes are congestive heart failure, infection and malignancy. The presence of a pleural effusion is related with high mortality, despite any causative factor.[1] The procedure for removal of abnormal pleural fluid through cannula is known as thoracocentesis or thoracentesis and in simple terms as pleural tap or aspiration. Thoracentesis improves symptoms and quality of life. Large volume thoracentesis means removal of more than one liter of pleural fluid during thoracentesis.[2]

The complications of thoracentesis include pneum-

othorax, re-expansion pulmonary edema and bleeding. Simple aspiration or chest tube insertion can be done for larger or symptomatic pneumothorax, which can prolong patient's hospital stay.[3] It is clinical practice to obtain chest radiograph after every thoracentesis procedure to rule out pneumothorax.

Many factors have been considered to affect the rate of pneumothorax; including ultrasound assistance, position of the patient during procedure, volume of pleural fluid drained, patient's medical condition and gauge of needle used.[4,5] Our study focuses on amount of pleural fluid, because this is one of the factors which can be modified while performing thoracentesis.

The maximum amount of fluid that can be cautiously drained during therapeutic thoracentesis is undecided due to lack of studies on large volume thoracentesis.[5-7] The risk of iatrogenic pneumothorax increases with the amount of fluid withdrawn, although some patients appear to withstand larger volumes of fluid removal than others. This was established by Josephson et al,[8] according to which compared to a thoracentesis of 0.8-1.2 L, removal of 1.8-2.2 L was associated with a more than three times increase in risk for pneumothorax and, after aspiration of 2.3 L or more, the increase in risk was almost six times. According to another study conducted by Ault et al. pneumothorax was significantly associated with aspiration of more than 1500 ml fluid.[4] In contrast to these studies, the study of Barnes et al. has stated that there is no correlation of aspirated fluid volume with occurrence of pneumothorax.[9]

Rehman et al.[10] demonstrated 6% frequency of pneumothorax in his study. Similarly Gordon et al.6 showed the overall pneumothorax rate of 6.0%, among which 34.1% of pneumothoraxes needed chest tube insertion. Pneumothorax rates were higher for therapeutic or large volume thoracentesis than for diagnostic procedures (8.4% vs 5.2%) according to this study.

A general clinical practice to reduce pneumothorax has been to stop fluid aspiration at the onset of chest discomfort or when the total volume of fluid removed reaches 1000 to 1500 ml. However, this practice does not prevent pneumothorax all the time and in fact, many patients do fine with removal of more than 1500 mL.

The aim of this study is to study the frequency of pneumothorax in patients undergoing large volume thoracocentesis to establish a cut off level or value to prevent iatrogenic pneumothorax. This will assist us in proposing a safe level for pleural volume drainage which can turn into a benchmark to be used in future clinical guidelines.

Objectives

Objective of the present study was to determine the frequency of pneumothorax in patients undergoing large volume thoracocentesis.

Methodology:

This cross sectional prospective study was conducted at the Department of medicine, Mufti Mehmood teaching hospital D. I. Khan. Study duration was 6 months from 1st September 2019 to 28th February 2020. Study samples were collected through non-probability consecutive sampling. Sample size was 241, calculated on the basis of 6%7 pneumothorax rates in thoracocentesis using 5% margin of error and 95% confidence interval under the WHO formula for sample size determination in health studies. For study cases, strict inclusion and inclusion criteria was followed. Inclusion criteria include patients of any gender with age of 20-70 years, with pleural effusion of 1000ml or more showed on ultrasound and with thoracentesis volume of 1000 ml to 2500 ml, whereas exclusive criteria for this study was to excluded all such patients having established pneumothorax before performing thoracentesis or patients with underlying chronic lung disease as these patients are more vulnerable to develop pneumothorax.

Data Collection Procedure

After informed consent taken from the patient, all patients with inclusion and exclusion criteria were subjected to history and examination. Demographic details like patient's age and gender were recorded. All Patients underwent thoracocentesis by medical consultant and then immediately followed by a chest radiograph in an erect position. 16-G IV cannula was used for thoracentesis. The amount of fluid aspirated and presence or absence of pneumothorax was recorded. Strict exclusion criteria had been followed to control confounders and study bias.

Table 1. Gender distribution of study cases

Gender	Numbers	Percentage
Male	128	53.1
Female	113	46.9
Total	241	100

Table 2. Gender distribution of study cases

Age group (Years)	Numbers	Percentage
21-30	57	23.6
31-40	82	34
41-50	71	29
51-60	14	7.1
61-70	17	5.8
Total	241	100

Statistical Analysis

SPSS Version 16 for data entry and analysis was used. Descriptive statistics were calculated for both qualitative and quantitative variables. For qualitative variables; like gender and pneumothorax, we calculated frequency and percentage. Mean and standard deviation was calculated for quantitative variables like age, volume aspirated. Frequency of pneumothorax based on volume was calculated. Post stratification chi-square test was applied. Effect modifiers like age, gender will be controlled.

Results

Out of 241 patients, 113(46.9%) were female and 128(53.1%) male (Table 1). 23.6% patients were in age range of 20-30 years, 34% patients were in age range 31-40 years, 29% patients were in age range 41-50 years, 7.1% patients were in age range 51-60 years and 5.8 % were in age range of 61 to 70 years (Table 2). Mean age of the study population was 38.9 years with SD ± 11.27 and range of 20-69 years. Mean aspirated volume of pleural fluid was 1525 ml with SD ± 396 and range of 1022 to 2400 ml.

Only 34 patients (14.1%) developed pneumothorax (Figure 1). Out of 128 male patients, 21 developed pneumothorax while among female patients 13 out of 113 developed pneumothorax. Chances of pneumothorax development were also found to be increased in those with multiple attempts of aspiration as compared to fewer attempts (Table 3).

Discussion

Pleural effusion is the manifestation of a number of localized and systemic diseases like pneumonia, tuberculosis, cardiac failure etc. Thoracentesis is often required for diagnostic and therapeutic purposes. Iatrogenic pneumothoraxes resulting from thoracentesis increase morbidity, mortality, and length of hospitalization.[6] Chest tube insertion may be required in up to 50% of cases.[11]

The overall frequency of pneumothorax varies from Centre to centre.[12] Colt et al described pneumothorax frequency of 5.4% in his study on 255 patients.[13] Jones et al observed pneumothorax in 24 thoracentesis out of 941(2.5%). Raptopoulos et al found 3 cases of pneumothorax out of 188 ultrasound guided thoracocentesis with frequency of 3%.

According to meta-analysis by Gordon et al,[6] the overall pneumothorax rate was 6 % with range of pneumothorax rates among individual studies varied from 0% to 19.2%, while the pneumothorax rate in our study is 14.1%, which is within the range of meta-analysis; although it is on a higher side. The higher side of occurrence may be because of limited use of ultrasonography guidance of thoracentesis in our facility. Patel et al.[14] also demonstrated pneumothorax rate of 4.0% to 30.3% which is the range our study results fall in. the range of this study from very to

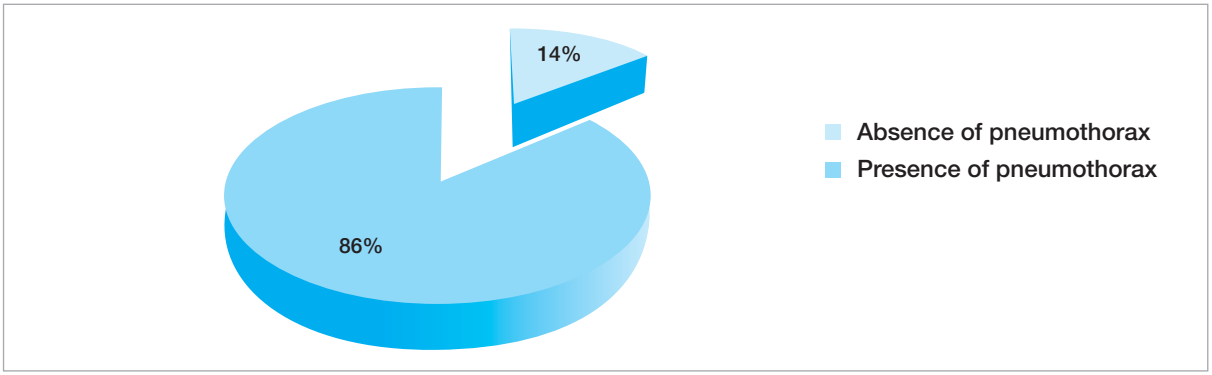

Figure 1: Frequency of pneumothorax among study population

Table 3. Distribution of pneumothax among patients with number of needle passes/attempts

No of needle passing attempts	Pneumothorax	
	Yes (%) N = 34	No (%) N = 207
1	14 (10.8%)	115 (89.2)
2	10 (18.8%)	43 (81.2)
3	8 (20.5%)	31 (79.5)
4	2 (10.0%)	18 (90.0)

higher side might be because of two groups, one with ultrasound guidance and the other without. Our study didn't use ultrasound for pleural tape.

The risk of pneumothorax with increased number of passes. According to Lichtenstein et al.[15] pneumothorax rates were higher for procedures requiring 2 or more passes than for those completed in 1 pass. The increase in number of passes equal to 2 or more is associated with increased risk of pneumothorax. Our study showed that the risk of pneumothorax with single pass is 10.9 %, while that with double pass is 18.9% and with triple pass is 20.5%. The result with four passes in our study showed pneumothorax rate of 10%, which is most likely due to less number of patients undergoing 4 passes, which is.[20]

In the present study less number of females developed pneumothorax as compared to males. Although it's not statistically significant and might be because other factors but there must some investigation if they have some protective mechanism. Literature review does not show any such relevance.

We are aware of the limitations of our study, which include the fact that patients on mechanical ventilation were not enrolled and the fact that real-time ultrasound guidance was not performed. Other factors like patient symptoms, pleural pressures, skin thickness of the patients and repeated procedures are also not addressed in our study.

There is need of research studies incorporating all the risk factors of development of pneumothorax associated with thoracentesis and what are the factors that can prevent its occurrence.

Conclusion

The risk of pneumothorax increases with increase in volume of thoracentesis. Risk versus benefit should be evaluated in attempting large fluid aspiration.

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