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Study Of Changes In Pulmonary Functions After Therapeutic Thoracocentesis In Pleural Effusion

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Abstract

Introduction:

Pleural effusion is an accumulation of excessive fluid in the pleural space. In patients with pleural effusion, alterations in physiological states leading to restrictive lung functions and hypoxemia have been recognized. Patients with large pleural effusions often experience rapid relief from dyspnoea after removing the pleural effusion. The physiological explanation of the subjective improvement is still unclear. So, we have done this study to determine the effects of therapeutic thoracocentesis in patients with pleural effusion by assessing spirometric values.

Material And Methods:

The study included a total of 50 patients with pleural effusion admitted to the medicine and pulmonology department based on inclusion and exclusion criteria. All patients were further classified in mild, moderate, and massive pleural effusion based on chest x-ray. Therapeutic thoracocentesis was done in all patients. Spirometry was done in all patients with RMS Helios 401 spirometer both before and after completing thoracocentesis. Spirometric measurements for FEV1, FVC, FEV1/FVC % were performed according to the defined criteria by the American Thoracic Society. We did a statistical analysis with SPSS software version 12.0, and P-value < 0.05 was considered statistically significant.

Results:

Our study has seen an inverse relation of the amount of pleural effusion with spirometric parameters like FVC, FEV1, and FEV1/FVC%.

Conclusion:

Pulmonary function tests set up clearly that pleural effusion produces a restrictive pattern. After therapeutic thoracocentesis, we found significant improvement in FVC, FEV1, and FEV1/FVC%.

Keywords: Pleural effusion, Spirometry, Pulmonary Function Tests (PFT)

Introduction

Pleural effusion is an accumulation of excessive fluid in the pleural space, the potential space that surrounds each lung. The clinical recognition of pleural effusion signals on an abnormal pathophysiologic state has resulted in dysequilibrium between pleural fluid formation and removal [1]. Pleural effusion is suspected when blunting and medial displacement of the sharp costophrenic angle on posterior-anterior view chest x-ray. Sometimes this view does not show the effusion while the lateral decubitus view does [2,3]. It is divided into three grades of severity: mild, moderate, and severe according to the amount of fluid and degree of

obliteration of lungs field through clinical examination and chest x-ray findings [2,3].

Therapeutic thoracocentesis involves removing a considerable amount of fluid. Still, no more than 1000- 1500ml should be aspirated at one time because of pulmonary edema that may occur in the re-expansion of the underlying lung [2,3].

In patients with pleural effusion, alterations in physiological states leading to restrictive lung functions and hypoxemia have been recognized [4-6]. Lung function changes associated with pleural effusion include restrictive lung volumes and decreased lung compliance [7-9]. Patients with large pleural effusions often experience rapid relief from dyspnoea after removing the pleural effusion. The physiological explanation of the subjective improvement is still unclear. When a pleural effusion is removed from a hemithorax, either the lung must expand to fill the space or the hemithorax must get smaller.

Earlier studies have shown either no definite improvement [7,10,11] in pulmonary function tests or a relatively small improvement in pulmonary function after therapeutic thoracocentesis [12,13]. So, we have done this study to determine the effects of therapeutic thoracocentesis in patients with pleural effusion by assessing spirometric values.

Objectives:

Study the effects of therapeutic thoracocentesis in patients with pleural effusion by assessing spirometric values.

Material And Methods:

It is an open-label observational study done at C. U. Shah medical college & Hospital, Surendranagar, Gujarat. The study included a total of 50 patients with pleural effusion admitted to the medicine and pulmonology department based on inclusion and exclusion criteria. All patients above 15 years of age having pleural effusion of more than 100 ml were included in the study. We have excluded patients with pleural effusion associated with pulmonary tuberculosis, connective tissue disorders, interstitial lung disease, obstructive lung disease like asthma, COPD, trapped lung, encysted pleural effusion, and pleural effusion complicated by pneumothorax or hydropneumothorax, pregnant female and patients on corticosteroid therapy and chronic smoker patients.

We took informed written consent from all patients. We did a clinical examination, sputum for AFB, and routine blood investigation like CBC, RBS, HIV, serum LDH, serum Protein, creatinine in all patients. All patients were further classified in mild, moderate, and massive pleural effusion based on chest x-ray. Patients with pleural effusion level up to lower border of fourth rib anteriorly were classified as mild effusion, up to lower border of the second rib as moderate effusion, and above the second rib as massive pleural effusion.

Therapeutic thoracocentesis was done in all patients continued until no more fluid was obtained or patients had symptoms like chest pain, breathlessness, or coughing. Pleural fluid investigations like colour, appearance, glucose, protein, total count, differential count, ADA, and cytology were recorded in all patients.

Spirometry was done in all patients with RMS Helios 401 spirometer both before and after completing thoracocentesis. Each patient was recommended to sit over a stool for 5 minutes followed by a blow-in mouthpiece through their mouth with maximal effort. Spirometric measurements for FEV1, FVC, FEV1/FVC % were performed according to the defined criteria by the American Thoracic Society. All tests were repeated three times, and we calculated the mean value. We did a statistical analysis with SPSS software version 12.0, and the p-value for each parameter was calculated using the 'z' table. P-value < 0.05 was considered statistically significant

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Results:

Table 1: Age and Sex wise distribution of patients with pleural effusion

Age Group (Years)	Male	Female	Total
16-25	8	6	14

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26-35	6	1	7
36-45	7	5	12
46-55	3	2	5
>55	6	6	12
Total	30.00	20.00	50.00
Mean Age (Years)	37.83	41.35	39.14
Mean Weight (Kg.)	69.13	50.30	61.60
Mean Height (Cm.)	161.60	152.50	157.96

In this study, we have included a total of 50 patients with pleural effusion. Among them, 30 patients were male, and 20 were female. The maximum number of patients was in the age group of 16-25 years that was 14 patients, followed by 12 patients in the age group of 36-45 years and >55 years each. In our study, the mean age was 39.14 years. Mean height and weight were 157.96 cm and 61.60 kg., respectively.

Table 2: Distribution of patients based on the amount of pleural effusion

Age group (Years)	**Mild effusion**		**Moderate effusion**		**Massive effusion**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
16-25	2	2	4	2	2	2
26-35	0	0	3	1	3	0
36-45	2	2	5	3	0	0
46-55	0	1	3	0	0	1
>55	1	2	3	3	2	1
Total	**5**	**7**	**18**	**9**	**7**	**4**

In our study, a maximum number of patients (27 patients) had moderate effusion followed mild and massive effusion in 12 and 11 patients, respectively.

Table 3: Spirometric parameters before and after thoracocentesis according to the amount of pleural effusion

Spirometry Parameters In liters	**All patients**		**Mild effusion**		**Moderate effusion**		**Massive effusion**	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
FVC	1.32	1.60	1.64	1.88	1.24	1.53	1.15	1.44
FEV1	1.05	1.44	1.26	1.65	1.01	1.41	0.92	1.31
FEV1/FVC%	79.55	90.00	76.83	87.77	81.45	92.16	80.00	90.97

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In all patients before thoracocentesis, FVC, FEV1, and FEV1/FVC% were 1.32, 1.05, and 79.55%, respectively. After thoracocentesis in all patients, FVC, FEV1, FEV1/FVC% were improved to 1.60, 1.44, and 90%, respectively. We have also seen similar improvement in all three spirometric parameters among mild, moderate, and massive effusion after thoracocentesis.

Table 4: Spirometric parameters in all cases of pleural effusion before and after therapeutic thoracocentesis.

PFT parameters in liters	Before Thoracocentesis	After Thoracocentesis	P value
FVC	1.32	1.60	<0.001
FEV1	1.05	1.44	<0.001
FEV1/FVC%	79.55	90.00	<0.001

Our study has seen a change in FVC from 1.32 to 1.60, change in FEV1 1.05 to 1.44, change in FEV1/FVC% 79.55% to 90% after therapeutic thoracocentesis. The P-value for each spirometric parameter was significant (P-value < 0.001).

Discussion:

Pulmonary function tests have been proven to be valuable in diagnosis and guiding therapy. It has eased a better understanding of the respiratory disease, especially among those patients in whom clinical examination and radiological studies reveal little or no abnormalities.

In our study, we have included a total of 50 patients admitted at C. U. Shah Medical College and hospital as per inclusion and exclusion criteria. Among them, 30 (60%) patients were male, while 20 (40%) patients were female. The maximum number of patients (14 patients) were in the age group of 16-25 years, while the lowest number of patients (5 patients) were 46-55 years. The mean age of male patients was 37.83, and the mean age of the female patient was 41.35 years.

A study done by Rupak Singla [14] et al. has an average height of 1.60±0.08mts and mean age was 26.6 ± 11.0 with a range of 13-70 years. In our study, average height and weight were 157.96 cm and 61.60 kg., respectively. The range of age was 16-67 years.

The severity of pleural effusion on lung functions has not been studied earlier. This study has divided all patients into mild, moderate, and massive pleural effusion based on a chest x-ray. The effusion was mild in 24%, moderate in 54%, and massive in 22% of patients with pleural effusion. The mean amount of pleural effusion aspirated was 831.20 ml. We see that the value of spirometric parameters like FVC and FEV1 were significantly low in massive effusion followed by moderate and mild effusion. All spirometric parameters showed a significant amount of improvement (p-value <0.001) after thoracocentesis in each mild, moderate, and massive category of pleural effusion. A similar study by Rupak Singla [14] et al. saw that pulmonary function tests in pleural effusion show moderate restrictive abnormalities with mildly reduced diffusion capacity, and this derangement of pulmonary function tests is proportional to the severity of pleural effusion. Another study performed by Falah a Deli [15] et al. also saw comparable results.

Forceful maneuvers like forced vital capacity (FVC) and forced expiratory volume in 1 sec. (FEV1) have shown a significant improvement in their function with a p-value of 0.001, respectively. This study is comparable with the work done by Light RW [16] et al. (1995), who concluded that improvement in FVC after thoracentesis is small concerning the amount of fluid withdrawn.

Wang JSet [17] et al. has studied the change in pulmonary mechanics and gas exchange following thoracentesis in patients with inversion of the diaphragm in pleural effusion concluded that there is a small but significant improvement in FVC & FEV1 (p=0.001).

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Previous studies have shown that pleural effusions are associated with restrictive impairment and hypoxemia [8,9] and that any increase in lung volume after thoracocentesis is in proportion to the amount of fluid withdrawn [12]. The small increases in lung volumes reported are associated with a mild rise in static expiratory pulmonary compliance and a shift of the pressure-volume curve of the lung so that the lung recoil pressure decreases at any comparable lung volume.

The mechanism may be either a generalized decrease in the surface tension of the alveolar lining layer due to breathing at a higher lung volume [18] or decompression of the lung with reopening of some air spaces [12]. The improvement in dyspnoea in patients after thoracocentesis cannot be explained entirely by the improvement in the pulmonary function test results, which is small relative to the amount of fluid withdrawn.

Following thoracocentesis, there will be either a decrease in the thoracic cavity's size or an increase in pulmonary volume, or both. The relative changes in pulmonary volume compared with the size of the thoracic cage will depend upon the compliance of the lung compared with the compliance of the chest wall/diaphragm.

In contrast to our study, few studies have failed to improve pulmonary function after therapeutic thoracocentesis [19]. Ideally, the underlying diseases of the study participants should be similar across studies. The length of time the effusion has been present, and the volume aspirated may also affect the response. There may be increased interstitial capillary permeability [20] or an alteration of surfactant synthesis in the compressed lung that increases with time and volume [21]. Some studies have shown significant improvement after removing as little as 800 mL of pleural fluid [16].

Our study observed a restrictive pattern seen in the lungs, which shows a significant improvement in both symptom and lung volumes after thoracentesis.

Conclusion:

Our study has seen an inverse relation of the amount of pleural effusion with spirometric parameters like FVC, FEV1, and FEV1/FVC%. Pulmonary function tests set up clearly that pleural effusion produces a restrictive pattern. After therapeutic thoracocentesis, we found significant improvement in FVC, FEV1, and FEV1/FVC%.

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