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Effect of Positioning on Pulmonary Functions in Unilateral Pleural Effusion

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Abstract

Background: Pleural effusion is an abnormal accumulation of fluid in the intra-pleural space. The relative annual incidence of pleural effusion is estimated to be 320 per 100,000 people in industrialized countries. In pleural effusion positioning may be used to optimize gas-exchange. The therapeutic body positioning is a primary non-invasive physical-therapy intervention.

Methodology: The presence of pleural effusion was assessed by physical examination and chest X-ray. Pulmonary function testing (RMS HELIOS Spirometer) was conducted in sitting, right and left lateral decubitus positions. A forced expiratory maneuver was performed three times in each position after maintaining that position for 20 minutes and with rest as needed by the patient, between trials. It was made sure that subjects understood the instructions and performed the test with standard guideline (ATS Guidelines). The best values of forced vital capacity (FVC) and forced expiratory volume (FEV) were analyzed.

Results: No significant difference (p >0.10) was noted in FVC, FEV1 and FEV1/FVC values between the three positions. Although, mean values of FVC, FEV1 in sitting position (41.6 ± 12.20) was higher than mean value of FVC, FEV1 of lateral positions. In lateral decubitus position the mean FVC, FEV1 value of effusion lung upper most (37.8 ± 11.50) was slightly higher than effusion lung dependant (36.5 ± 12.8).

Conclusion: Position does not appear to have a significant effect on PFT in unilateral effusion patients.

Keywords: Pleural effusion, PFT (pulmonary function test), body position.

Introduction

Pleural effusion is an abnormal accumulation of fluid in the intra-pleural space.[1] The relative annual incidence of pleural effusion is estimated to be 320 per 100,000 people in industrialized countries.[2] Pleural fluid accumulation either displaces lung tissue or restricts the opening of adjacent alveolar sacs. It poses a unique threat to oxygen transport as a result of its direct physical effect on the lung, heart or both.[3] In pleural effusion positioning may be used to optimize gas-exchange.[4] Studies have shown that position will have effect on intra-pleural pressure and on ventilation.[5] The therapeutic body positioning is a primary non-invasive physical-therapy intervention.

Aim

This study was designed to investigate the effects of different body positioning on pulmonary function tests in unilateral pleural effusion patients.

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Objectives

To find out

1. The effect of different body position on pulmonary functions
2. The most beneficial body position
3. The least beneficial body position.

Materials and Methods

Study design: Experimental, crossover design

Sampling technique: non-probability sampling

Sample size: 25

Inclusion Criteria

- Subjects, irrespective of sex, of the age group 20–50 years with unilateral pleural effusion.
- Patients who are able to comprehend commands and willing to participate.

Exclusion Criteria

- Bilateral pleural effusion.
- Hemodynamically unstable patients
- Any neuromuscular conditions preventing from assuming the required positions and performing the test.

Procedure: After getting the written inform consent and according to inclusion and exclusion criteria the subjects were enrolled in the study. The presence of pleural effusion was assessed by physical examination (chest expansion, auscultation; etc.) and chest X-ray (level of fluid-size of effusion). Subjects were instructed to refrain from vigorous exercise and eating a heavy meal within 2 hours of the test and to wear comfortable, non-restrictive clothing.

Pulmonary function testing (RMS HELIOS Spirometer) was conducted in sitting, right and left lateral decubitus positions. A forced expiratory maneuver was performed three times in each position after maintaining that position for 20 minutes and with rest as needed by the patient, between trials.

It was made sure that subjects understood the instructions and performed the test with standard guideline (ATS Guidelines). The best values of forced vital capacity (FVC) and forced expiratory volume (FEV) were analyzed.

Fig. 1: Right lateral position.

Fig. 2: Sitting position.

Fig. 3: Left lateral position.

Outcome Measures

FVC, forced expiratory volume in 1 second (FEV1) and FEV1/FVC

Data Analysis

The outcome was cross matched with the expected values and with each three positional value. Parameters was expressed as mean values ± standard deviation. Analysis of variance was used to determine the effect of body position on Spirometric parameters.

Results

No significant difference ($p > 0.10$) was noted in FVC, FEV1 and FEV1/FVC values between the three positions. Although, mean values of FVC, FEV1 in sitting position (41.6 ± 12.20) was higher than mean value of FVC, FEV1 of lateral positions. In lateral decubitus position the mean FVC, FEV1

Table 1: Clinical data of 21 patients of pleural effusion (TB = Tuberculosis, CA = Carcinoma, S = Severe, Mod = Moderate, R = Right, L = Left) - (dropout -4)

Characteristics of patients	Mean ± SD	No. of patient
Sex M/F	16/5	
Age (years)	33.3 ± 10.7	21
Diagnosis, TB/CA	20/1	
Effusion side R/L	15/6	
Height	16.4 ± 7.3	
Weight	46.5 ± 6.07	
Effusion S/ Mod/ Mild	14/6/1	

Table 2: Sirometric data of 21 patients

Position	No. of Subjects	FVC Mean ± SD	FEV1 Mean ± SD	FEV1/FVC Mean ± SD	*p*-value
Sitting	21	41.6 ± 12.20	49.09 ± 19.7	113.24 ± 17.75	
Effusion lung up	21	37.8 ± 11.50	43.86 ± 14.43	115.14 ± 6.68	> 0.10
Effusion lung down	21	36.5 ± 12.8	42.95 ± 14.90	118.52 ± 8.18	

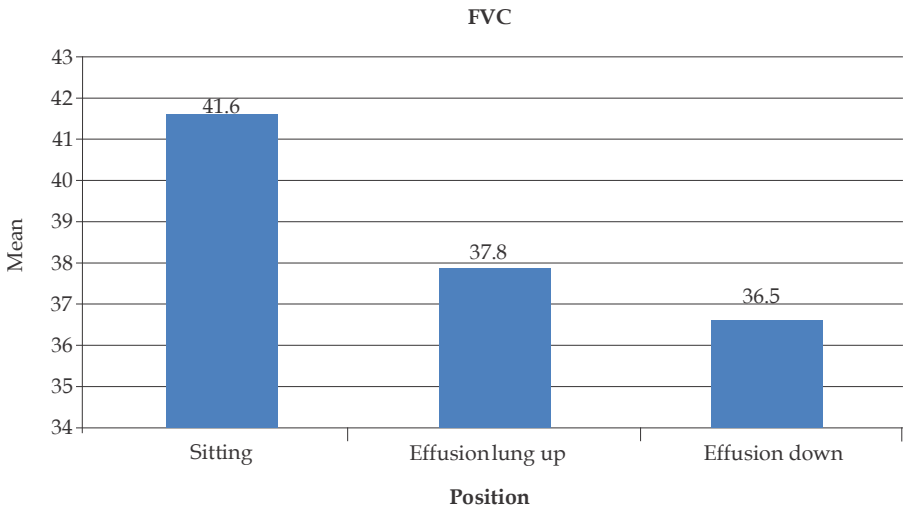

Fig. 4: FVC

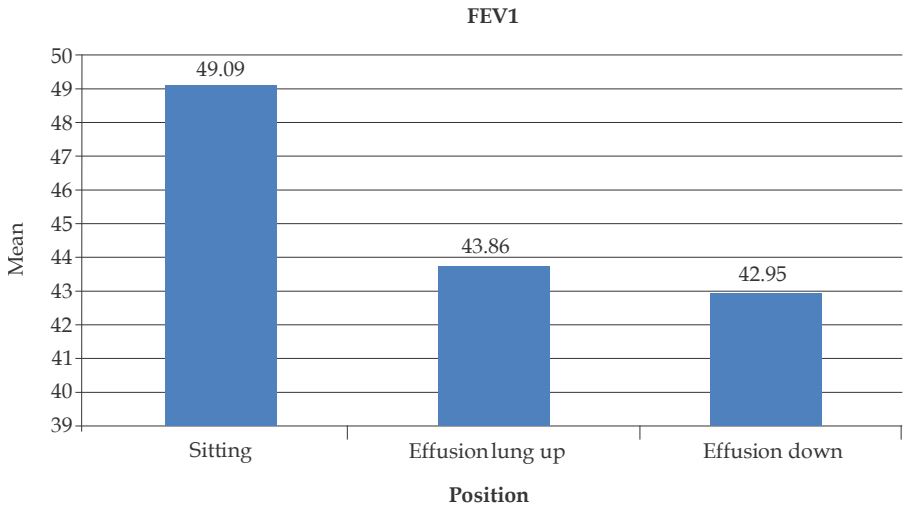

Fig. 5: FEV1

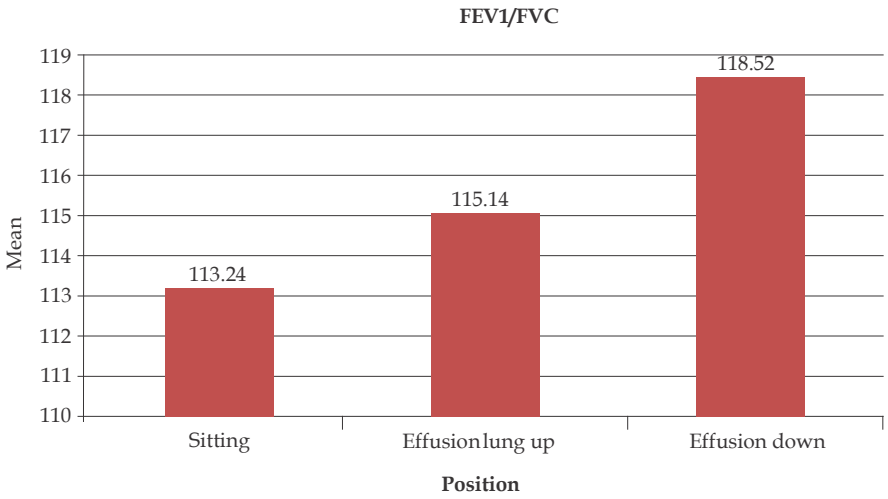

Fig. 6: FEV1/FVC

value of effusion lung upper most (37.8 ± 11.50) was slightly higher than effusion lung dependant (36.5 ± 12.8) (Figs. 4–6).

Discussion

The study was conducted to find out the effect of body position on pulmonary function test in unilateral pleural effusion patients. Therapeutic interventions were given to 21 subjects. Out of 21 patients 16 were male and 5 were female. The mean age was 33.3 ± 10.7.

In the study by spirometry FVC, FEV1, and FEV% readings were taken to find out restriction and it's severity. FVC was taken as outcome measure for the study to find out effect of position on PFT. The result showed no significant difference in FVC values of all three positioning. So, our results showed that the change in body position did not significantly affect FVC ventilation in the patients with various degree of pleural effusion.

Although, the present study showed that mean values of FVC in sitting position is higher than mean value of FVC of lateral positions. In lateral decubitus position the mean FVC value of effusion lung up is slightly higher than effusion lung down.

SR Neagley and CW Zwillich (1985) did study on "The effect of positional changes on oxygenation in patient with pleural effusion" in 10 asymetrical pleural effusion patients and measure arterial oxygen saturation (SaO_2) in sitting, supine, left and right lateral decubitus positions and concluded that there is no significant relationship between the size of the pleural effusion and the amount of arterial oxygen desaturation. They stated that there is a decrease in SaO_2 in normoxic patients when the side with large pleural effusion is dependent.[6]

However, Shi-Chuan Chang and, Guang-Ming Shiao (1989) did study on "Postural effect on gas exchange in patients with unilateral pleural effusion" by measuring arterial oxygen tension in 21 patients in right and left lateral decubitus positions have shown that PaO_2 values was higher when they were positioned in the lateral decubitus position with normal lung down. But when severe restriction present the reverse applied.[7]

They stated that, pleural fluid decrease lung volume, renders intra-pleural pressure lee negative, and, thus decreases ventilation to the lung on the side with effusion. It may also increases closing volume. This effect of pleural fluid on ventilation may lower the overall ventilation-perfusion ratios in the lung on the side with the effusion and cause hypoxemia. when the patients with the unilateral pleural effusion lie in the lateral decubitus position with the pleural effusion dependent, one may anticipate that worsening of ventilation-perfusion inequality will ensue because gravity increases the perfusion to the lung in which there is low ventilation-perfusion ratios. However, when the patients are positioned in the lateral decubitus postion with the normal lung down, blood is shifted away from this area to better ventilation lung with an improvement in oxygenation.

When effusion amount is large, pleural fluid may begin to move an impact on perfusion and decrease blood to the lung on the side with effusion. The mechanism responsible for this decrease in blood flow may be mechanical and/or due to hypoxia vasoconstriction resulting from local hypoxia in the lung on the affected side. This effect may be more

pronounced in the position when the side with the pleural fluid is dependent. This effect may shift both ventilation and perfusion to the contralateral normal lung. Accordingly, when the patients lie on the lung with effusion dependent, there is no further worsening of gas-exchange.

In contrast, when the patients lie on the lung without pleural effusion a compressive effect on the dependent normal lung exerted by contralateral side effusion may induce ventilation perfusion mismatch because gravity increases perfusion to this poorer ventilated lung.

These both above study show difference in their results. However, in the present study the difference in FVC is non-significant, a minute difference in FVC of two lateral decubitus shows better FVC with good lung down. However, we chose to monitor FVC rather than SaO_2 or PaO_2.

W.S. Druz et al. (1981) did study on "Activity of respiratory muscle in upright and recumbent humans" in nine subjects and have shown that the increase rib-cage motion characteristic of the upright posture owes to a combination of increased activation of rib-cage inspiratory muscles plus greater activation of the diaphragm that, together with a stiffened abdomen, act to move the rib cage more effectively.[8]

Position of the neck may alter the longitudinal tension on the trachea and thus tracheal stiffness which may affect expiratory flow rates. In our study we kept the head in neutral position so this can not be applied.

In present study, no statistically significant difference is found in FVC values of three positions, however minute changes present in mean values in effort dependent expiratory flow rates between sitting and side lying position which could be due to increase in the resistance of upper airway on assuming horizontal posture as the pharyngeal size decreased significantly with lying posture and decrease rib-cage motion in lying as explained above.

In current study based on X-ray chest, the patient were divided in three groups: mild, moderate, and severe. The restrictive lung function abnormality in spirometer is indicated by reduced FVC, FEV1 and increased FVC%. This changes increases with increasing severity of pleural effusion. According to this spirometric reading pleural effusion was categorized into mild, moderate and severe. In present study out of 21 subjects 18 were shows correlation between roenterographic and spirometric finding.

So, spirometric reading can be used to interpret the severity of effusion when chest x-ray not available.

M. Sonnenblick et al. (1983) studied on "Body positional effect on gas-exchange in unilateral pleural effusion" in eight patients and stated that larger positional difference were found in the patients with the smallest pleural effusion. However, In present study only one subject was with mild pleural effusion out of 21.[9]

PK Behrakis et al. (1983)[10] studied on "Lung mechanics in sitting and horizontal body positions" in 10 healthy young adult and measured lung compliance and found both static and dynamic lung compliance decreased in the supine position, while in the lateral position intermediate values were obtained. The reduction in lung compliance in the horizontal posture cab probably be attributed to

1. Increased pulmonary blood volume, which decreases the recoil of the lung at low volumes.
2. To small airway closure

In the presence of cardiac or pulmonary conditions, position related effect on cardio-pulmonary status may be accentuated in left and right side lying position.

The present study did not show statistically significant difference in FVC values of right and left lateral decubitus position in unilateral pleural effusion patients. These findings are at variance with result of previous workers who stated a favorable gas exchange could be obtained exclusively in the patients with unilateral lung disorder, when they were positioned in the lateral decubitus position with normal lung down.

The reason for these discrepancies may be explained by the following.

1. Rather than taking gas exchange we have taken only FVC in consideration by measuring FVC
2. During inspiration the hydrostatic pressure of a pleural effusion tends to fall because of the increase in thorax volume, thereby increasing the total pressure difference. This would lead to an apparent decrease of compliance which is more marked at intra-pleural regions, while mechanical resistance would increase. So, it is recommended to take inspiratory parameters rather than FVC.

Conclusion and Clinical Significance

Position does not appear to have a significat effect on PFT in unilateral effusion patients. Further study required with more sample size including the other cardiorespiratory parameters (ABG, SpO_2, HR, RR etc.) and by subjective measurements.

Any three positions can use interchangeably during rest and during physiotherapy treatment.

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