

Effect of Different Positions on FVC and FEV₁ Measurements of Asthmatic Patients

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Abstract. [Purpose] The purpose of our study was to investigate the effect of different positions on pulmonary function test (PFT) values such as forced vital capacity (FVC) and forced expiratory volume in one second (FEV₁) of asthmatic patients. [Subjects and Methods] Thirty subjects with severe asthma aged between 20–39 years were enrolled after they had signed a written consent. Subjects were selected using the inclusion criteria, and PFT were randomly administered. Spirometer measurements (FVC, FEV₁) were taken in the supine, side lying on right, side lying on left, sitting and standing positions. Each measurement was taken three times, and the average values were analyzed. [Results] One- way analysis of variance (ANOVA) and Tukey's Test (post hoc) for pair- wise comparison indicated that there was a significant difference in the FEV₁ values of the asthmatic patients however a significant difference was obtained between standing and supine positions. There was also a significant difference in the FVC values between the standing and supine lying position in the pair -wise comparison. [Conclusion] This study showed standing is the best position for measuring FEV₁ and FVC of asthmatic subjects. The more upright the position, the higher the FEV₁ and FVC will be.

Key words: Pulmonary function test, Standing position, Spirometry

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INTRODUCTION

COPD is a common disease worldwide. It is the 4th leading cause of death. Worldwide prevalence of COPD ranges from 4–6%¹). The European Community Respiratory Health Survey (ECRHS) studied adults of 20–44 years at European centers, and found a high prevalence of reported asthma symptoms in Latin America and Western Europe, but a much lower prevalence in Eastern Europe, and even lower prevalences in Africa and Asia, with the exceptions of more affluent countries like Singapore and Malaysia²). The prevalence in India is documented as up to 4.1%, with figures of 5% for males and 3.2% for females^{3, 4}). Many researchers have reported significant changes in pulmonary function with positioning. Reductions of 12% for forced vital capacity and 15% for force expiratory volume in one second have been observed in normal individuals between the different body positions of sitting and slumped half lying⁵). Compared with the upright position, however, recumbent positions have well-documented deleterious effects on lung function, such as reduced lung volume and capacity,

increased closing volume of the dependent airways, reduced flow rates, and reduced arterial saturation. Positions affect respiratory muscle activity by changing the length of the respiratory muscles during rest and inducing changes in ventilation and perfusion, in particular, the maximum air exchange that occurs depends on gravity^{6–8}). Mean expiratory pressure and peak expiratory flow rate are influenced by lung volumes and muscle length-tension relationships, which in turn are influenced by body position⁹). Vital capacity has been found to be lowest in the fetal position compared to other body positions^{10–12}). The effects of breathing maneuver and sitting posture on the muscle activities of the inspiratory accessory muscles of patients with chronic obstructive pulmonary disease have been reported¹³).

Spirometry can be helpful in determining the effects of smoking on ventilator functions. It is the best method for detecting borderline to mild airway obstruction, which occurs early without the appearance of any symptoms or signs. FEV₁ is the most important spirometry measure for the assessment of airflow obstruction¹⁴). Current guidelines for asthma care categorize asthma severity based on the frequency of asthma symptom, medications used and mean lung function. For a reliable diagnosis lung function tests are necessary. In pronounced cases, a simple spirometry test measuring FEV₁ is sufficient.

Coughing and huffing are expiratory maneuvers that use high expiratory pressures and flow rates to aid airway secretion clearance. Physiotherapists encourage patients to cough and huff as part of a strategy to clear airway se-

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cretions in order to minimize complications. High expiratory flow rates and expiratory pressures are required for the production of strong and effective expiratory maneuvers^{15, 16}. The objective of this study was to investigate changes in pulmonary function values of asthmatic patients with change in position.

SUBJECTS AND METHODS

A sample of 30 subjects of both genders within the age group of 20–39 years who had moderate to severe asthma participated in this study (Table 1). They were recruited from Maharishi Markendeswar Institute of Medical Sciences, India. Ethical approval was gained from University Hospital Ethical Committee and the subjects gave their formal informed consent. Subjects with active infection, those taking medication within the past 6 weeks, or those with cardiovascular and neurovascular diseases, restrictive disorders, or a history of abdominal or thoracic surgery, and smokers were excluded. The Spiro Excel pc based pulmonary function test (PFT Medicaid Systems) was used for measurement. Force expiratory volume in one second (FEV₁) is the volume of air exhaled in the first second under force after a maximal inhalation. Forced vital capacity (FVC) is the total volume of air that can be exhaled during a maximal forced expiration effort

One hour before the measurement, instruction and demonstration was given to subjects on how to perform spirometry. FVC and FEV₁ were measured in the supine, right side lying, left side lying, sitting and standing positions. The order of the body positions was randomized, and the test positions were standardized: a) Sitting in a wooden chair with the trunk extended, hip and knee flexed, as near as possible at right angle. b) Lying on a bed with a pillow supporting the head and both legs are extended. c) Side lying: Left side lying with the right hip and right knee flexed at 90 degrees. Pillows were set under the right thigh and right arm and head to maintain the body position without effort and vice versa for the right side-lying position. Subjects lay on a flat stretcher with one pillow under the head, one pillow behind the back and against the stretcher rail or wall. The tester observed the subjects throughout the rest periods and the test maneuvers to ensure their maintenance of a full side-lying position with the head and neck in line with the torso. d) Erect standing without any support. Each measurement was done three times, and the average values were analyzed. Measurements were performed with subjects in a fasting state to avoid encumbering the diaphragm movement with gastric contents.

RESULTS

One-way analysis of variance (ANOVA) and Tukey's test for pair wise comparison of group means were used to evaluate the within group and between group differences of pulmonary function test values of asthmatic subjects in different positions. Both FEV₁ and FVC in the standing position were significantly ($p < 0.05$) higher than in the supine lying position. Tukey's test (post hoc) for pair-wise comparison of group means also showed that there were signifi-

Table 1. The characteristics of the sample

n=30 (Males=16 and Females=14)	Mean ± SD
Age (years)	34.3 ± 3.7
Height (cm)	166.5 ± 8.6
Weight (kg)	64.3 ± 8.2

cant differences in both FEV₁ and FVC values between the standing and supine positions.

DISCUSSION

In the present study, the effect of different positions on FEV₁ and FVC values of asthmatic patients was evaluated. The results of the present study have two major findings. First, there was a significant difference in the FEV₁ values of asthmatic patients between the standing and supine positions. There was also a significant difference in FVC between these two positions. Thus the null hypothesis was rejected. Some researchers have reported a relationship between respiratory function and posture. Previous studies reported FVC and FEV₁ were lower in the supine and prone positions compared to the sitting position. In the present study, these two positions and three other positions were compared in young asthmatic subjects. Differences in position and disease might influence the result; however spirometric values of obese asthmatic subjects with BMI ≥ 30 are not affected by sitting and standing positions¹⁷. The pressure caused by the intra-abdominal organ on the diaphragm is larger in the supine position than in sitting. Our results show that FEV₁ and FVC were lower in the supine position, and are inconsistent with the results of other studies which reported increased airway resistance in the supine position due to an increase in intra-thoracic blood volume^{18, 19}.

The results of the present study demonstrate that FEV₁ and FVC had higher values in the standing than in the supine position. The results are consistent with the other studies which have examined the change in FVC when changing position from standing to supine in young adults. This might be due to an increase in the diameter of the main airway in the standing position. When a person is upright the vertical gravitation gradient is at the maximum, the anterior – posterior diameter of the chest wall is greater, and the compression of lung and heart is minimized²⁰. However significant differences were not found between standing and the other positions of sitting, and right and left side-lying (Table 2).

A comparative study of COPD patients concluded that maximal expiratory pressure is augmented with progressively upright position in patients with COPD as well as in healthy individuals. Standing results in the highest maximal expiratory pressure values, and lowest in the supine position⁹. This result was not supported by Jenkins SC and Soutar SA, who showed that limited chest wall motion caused by posture did not have any effect on FVC of healthy young subjects²¹. To assess FEV₁, fast forced expiration is necessary. The expiratory muscle, mainly used in forced expiration in sitting and side-lying with most upper leg

Table 2. Estimates of group means of FEV₁ and FVC (liters)

Group	FEV ₁ (Mean ± SD)	FVC (Mean ± SD)
Standing	2.0 ± 0.5	2.5 ± 0.6
Sitting	1.9 ± 0.6	2.3 ± 0.6
Side lying Right	1.8 ± 0.5	2.3 ± 0.6
Side Lying Left	1.8 ± 0.5	2.2 ± 0.1
Supine Lying	1.7 ± 0.5	2.0 ± 0.5

Both FEV₁ and FVC values were highest to lowest in Standing > Sitting > side lying on right side > side lying on left side > supine lying

flexed, and one or both hip joints flexed is the rectus abdominus; therefore, FEV₁ values are lower in the supine position. Another study conducted with normal subjects showed that change in position from sitting to supine or prone resulted in significant changes in the respiratory pattern²². In lateral positions the lung function decreases because of lower capillary volume²³.

The results of this study will help in the selection of the best alternative position for the PFT for measuring FEV₁ and FVC. The standing position can be used for other therapeutic purposes. Body position has an effect on FEV₁ and FVC as measured by the PFT. Generally, the more upright the position, the higher the FEV₁ and FVC will be. These data suggest that at times, patients should be placed in the standing position while undergoing the PFT, to increase FEV₁ and FVC.

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