Influence of Different Body Positioning on Dynamic Lung Functions in Chronic Obstructive Pulmonary Disease Patients and in Normal Subjects–A Comparative Study

Abstract

Background and purpose: Chronic obstructive pulmonary disease represents a substantial economic and social burden throughout the world. Along with pharmacological interventions, all current treatment guidelines emphasize the role of pulmonary rehabilitation in COPD subjects for making them fit at their physical performance and activities of daily living but current treatment guidelines does not emphasize much about the role of body positioning in COPD subjects . The objective of this study was to determine the effect of different body positioning on dynamic lung functions in COPD and in normal subjects.

Methodology: Two groups consisting of 15 COPD and 15 normal subjects aged 40 to 65 years participated in the study. Their dynamic lung functions including FEV1, FEV6, FEV1/FEV6 and PEFR were measured in randomized order in different body positions i.e. standing, sitting, 3/4 sitting, long sitting, supine lying, sidelying right, sidelying left and headdown position.

Results: For all the lung functions, the calculated 'F' values when measured showed larger values than tabulated values in COPD and in normal groups.

Conclusion: It is concluded that there is significant difference in the effect of different body positioning on dynamic lung functions in COPD and normal subjects with the maximum results in standing and least in headdown position.

Keywords: Body Positioning; Dynamic lung functions; COPD

Research Article

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Mohankumar Thekkinkattil[1]*, TS Muthukumar[2] and R Monisha[3]

[1]*Chief Consultant and HOD Institute of Pulmonary Medicine and Research Sri Ramakrishna Hospital, India*

[2]*Professor and HOD Department of Cardio-Respiratory Phsyiotherapy College of Physiotherapy, India*

[3]*Post graduate Student College of Physiotherapy, India*

***Corresponding author:** Mohankumar Thekkinkattil, Chief Consultant and H.O.D Institute of Pulmonary Medicine and Research Sri Ramakrishna Hospital Coimbatore, Tamil Nadu, India, Email: drtmkcbe@gmail.com

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Introduction

Global Initiative for Chronic Obstructive Lung Disease (GOLD) defined COPD as a disease state characterized by airflow limitation that is not fully reversible and is usually progressive, associated with an abnormal inflammatory response of the lungs to noxious particles and gases [1]. In the Confronting COPD survey, 80% of patients had two or more symptoms on most or all days, such as breathlessness (45%), cough (46%) and sputum production (40%) [2]. The World Health Organization estimates that COPD is the fourth leading cause of death worldwide, with 2.74 million deaths in 2000 [3], and is projected to rank 5th in 2020 as a worldwide burden of disease [4]. The prevalence of physiologically defined chronic obstructive disease in adult aged ≥ 40 yrs is 9-10% [5].

Airflow limitation is the slowing of expiratory airflow as measured by spirometry, with a persistently low forced expiratory volume in the first second $(FEV)_1$ and a low ratio of FEV_1–to forced vital capacity (FVC),not reversible with treatment [6]. The current GOLD and American Thoracic Society/European Respiratory Society definition of airflow limitation is an FEV_1/FVC of < 70% measured with post bronchodilator lung function [1,7,8]. Recent well accepted treatment guidelines for COPD urges the use of spirometry and reversibility testing for diagnosis and monitoring [9]. Spirometry is a physiological screening test of general respiratory health that measures how an individual inhales or exhales volumes of air as a function of time. The primary signal measure in spirometry may be volume or flow [10]. The GOLD definition of COPD classified reversibility as an FEV_1 increase of 200mL and 12% improvement above baseline FEV_1 after either inhaled corticosteroids or bronchodilators [11].

A physiological variable- the FEV_1 is often used to grade the severity of COPD [12]. FEV_1 is central to definition of COPD and classification of its severity. Consequently FEV_1 and its change over time are important outcomes in COPD and valuable measures for the assessment of disease progression [13]. Body positioning helps in optimizing O_2 transport primarily by manipulating the effects of gravity on cardiopulmonary and cardiovascular functions [14]. Body position has been shown to affect lung volumes and muscle biomechanics. Higher lung volumes have been linked with better expiratory muscle length- tension relationship and improved expiratory pressures and flow rates. Peak expiratory flow rate (PEFR) has been used as surrogate measure of cough and huff strength [15]. The FEV_1 and PEFR are well correlated. Both FEV_1 and PEFR are most widely used and reproducible measures of forced expiration [16]. Body positioning is used during airway clearance treatments to alter lung volumes, reduce dyspnea [18], and maximize ventilation/perfusion matching [19].

Till date limited studies have been done to examine the effect of different body positioning on lung volumes and PEFR in the subjects with COPD. So the present study was undertaken to explore the effects of different body positioning on dynamic lung functions in COPD, so that the physiotherapists can recommend on positional changes that may increase the strength of coughing and huffing to enhance the clearance of mucus and which can be used as a part of home management programme to enhance mucus clearance in COPD subjects making them fit at their physical performance and activities of daily living.

Methodology

Study was carried out in Sri Ramakrishna hospital, Coimbatore. Non-probability randomized sampling method has been used. 30 subjects were included in the study i.e. 15 COPD subjects and 15 normal subjects with age ranging from 40 to 65 years. Their demographic profile and detailed medical record was collected through assessment.

Inclusion

Subjects were selected for the study if they fulfilled the following criteria:

a) Mild to Severe COPD patients (According to GOLD Criteria of COPD Severity, 2008).

b) Age between 40 to 65 years.

c) Both Male & Females.

Exclusion

a) Any history of thoracic surgery

b) Any history of abdominal surgery

c) Recent respiratory infections (Past 3 wks)

d) Haemoptysis of unknown origin

e) Pneumothorax

f) Unstable Cardiovascular Status

g) Recent Myocardial Infarction

h) Restrictive Lung Disease

i) Back Pain

j) Shoulder Pain

k) Oral or facial pain exacerbated by a mouth

l) Stress Incontinence

m) Dementia or confusional state

Instruments and tools

Instruments

A. Hand held Spirometer (Piko-6)

Piko-6 measures FEV_1, FEV_6 and the ratio of FEV_1/FEV_6. Piko-6 is very reliable source for measuring lung volumes with a reliability of 0.79 [20].

B. Peak Flow Meter

The SPIR-O-FLOW measures the peak expiratory flow (PEF) which is the muscular effort to exhale forcibly from fully inflated lungs.

SPIR-O-FLOW meets the new technical standards established by the National Asthma Education Program.

Assessment tool

A. MRC Dyspnoea Scale

Medical Research Council Dyspnoea Scale has graded the degree of breathlessness related to activities. It has grading from 1 to 5. MRC scale has interrater reliability of 0.92 [21].

Procedure

Screening of the subjects and allocation of subjects to groups was done by convenient sampling. Informed consent form was signed by the subjects before they participated in the study. Two groups were included in the study: Group A consisted of 15 COPD subjects and Group B consisted of 15 Normal subjects. The subjects were explained what the test will analyze and importance of their involvement for best results. The required procedural details were explained to the subjects and the rest period was given prior to testing.

The subjects were put into the required position, were made comfortable, their clothes were loosened and dentures were removed if they were loose (if present) and were instructed to hold the mouthpiece tightly and seal lips around it and then the subjects breathed into the spirometer (piko-6) and Peak Flow Meter (Spiro-o-flow). In Piko-6, the subjects were instructed to inhale rapidly and completely first and then encouraged to exhale fully and completely and keep breathing out till they can do so no more. Exhalation time suggested by American Thoracic Society (ATS) is 6 seconds unless the subjects cannot or should not continue to exhale further.

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The spirometer then digitally displayed the values of FEV_1, FEV_6 and FEV_1/FEV_6. The use of nose clip or manual occlusion of nares was done before the subjects started to expire. While in Peak Flow Meter after the point of full lung inflation, subjects were instructed to blow out air vigorously from the mouth without any delay however they need not had to perform the exhalation for 6 seconds. A nose clip is not required for this maneuver. It was checked that there was no false start, no hesitation and cough during the early part of the forced exhalation. It was also checked that adequate inspiration was there before subjects started to expire. Testing was postponed if the subject became short of breath, was too fatigued to continue, could not tolerate the position or was unable to perform the test correctly in that position. In accordance with the recommendations of American Thoracic Society a minimum of 3 trials in each position were obtained for FEV_1, FEV_6 & PEFR and out of 3 trials the highest value in each position was recorded.

If a variation of 0.150 litres were observed among the largest two values of FEV_1 and FEV_6, a 4^{th}, 5^{th} and sometimes 6^{th} trial in each position were obtained. And if the largest two out of three acceptable peak expiratory flows were not reproducible with in 40 litres/min upto 2 additional blows were performed.

Each subject was attended for 1 session which lasted for approximately $1^1/_2$ hours. Randomization between Piko-6 device and Spir-o-flow and of the different body positions was done by using chit method. Appropriate rest period was given to the subjects after they were put into next position.

The following different positions were used:

i. **Standing:** The subjects adopted a comfortable and erect standing position.

ii. **Chair sitting:** The subjects were seated in a chair with no arm rests and were instructed not to slouch forward nor lean to either side. Chairs were having a fixed, lightly padded back at 90° to the seating surface.

iii. **Long sitting:** The subjects were made to sit straight on a padded couch with legs straightened in front. The upper body formed a 90° angle to the legs. A wall positioned directly behind the couch supported the subject's upper body and a pillow was placed behind the lumbar spine to increase the comfort.

iv. **¾ Sitting:** The subjects were positioned on a padded plinth the top part of which was positioned at 45° angle. The subjects sat with their hips at the bend in the plinth and the upper body resting back on the segment of the plinth that was angled. This meant that the upper body formed an angle of approximately 135° with the legs.

v. **Supine lying:** The subjects were positioned lying on their backs on a padded couch. The hips were flexed at 45° angle with the soles of the feet in contact with the couch. This resulted in about 90° flexion at the knees. A pillow was placed under the head.

vi. **Side lying:** Subjects were made to lie on the right and left side alternatively on a padded couch. The hips were flexed at 45° and the knees were flexed to 90°. A pillow was placed under the head.

vii. **Head down:** The subjects were positioned on a padded tilt table. The table was tilted so that the subject's body was at 20 degrees angle with the head lower than the feet.

Statistical Analysis

Data collected was analyzed using ANOVA (software based analysis) to measure the effect of different body positions on dynamic lung function values within the groups (one way ANOVA) and between the groups (two way ANOVA).

Results

Using ANOVA, the Calculated 'F' values of FEV_1, FEV_6, FEV_1/FEV_6 and PEFR were larger than the tabulated values in COPD and Normal group comparative analysis suggesting that there is significant difference in the effect of different body positions on dynamic lung functions across 2 groups (Graphs 1-4).

Discussion

Evidence show that large number of COPD subjects experience lung volumes and flow rates impairment due to disease process. This abnormal lung function is referred as expiratory airflow limitation. Different body positioning is aimed at maximizing the lung volumes and flow rates which can be utilized to prescribe body positioning in COPD and normal subjects thus increasing expiratory flow rates and volumes which will help in increasing coughing and huffing strength and in turn lead to mucus clearance.

Effect of body positions on these parameters were analyzed using ANOVA. FEV_1, FEV_6 and PEFR attained the highest values in the standing position followed by sitting having slightly more value than ¾ sitting which in turn is much higher than long sitting followed by supine lying, side lying (Rt.) and side lying (Lt.). Lowest values were observed in head down position. Similar trends were observed in COPD and Normal subjects.

FEV_1/FEV_6 followed same trend for all the positions in the Normal subjects where as in COPD side lying (Lt.) showed slightly higher values than side lying (Rt.) while all the other positions followed the same fashion. A significant difference in the effect of different body positioning on Dynamic lung functions were observed in COPD and normal subjects. Improvement in dynamic lung functions in more upright positions is noticed in this study which may be due to the reason that in more upright positions gravity pulls the abdominal contents caudally within the abdominal cavity thus increasing the vertical diameter of thorax resulting in increased lung volumes and elastic recoil of lungs, while in recumbent positions the abdominal contents are higher in the abdominal cavity which may interfere with the motion of diaphragm resulting in lower lung volumes and flow rates.

Limitations

a) Maximal expiratory pressure measurement was not taken.

b) No measurement of diaphragm position was conducted.

c) The effect of obesity and postural abnormalities on pulmonary functions was not assessed.

d) Clinically therapeutic benefits were not assessed.

e) Correlations within the positions were not analyzed.

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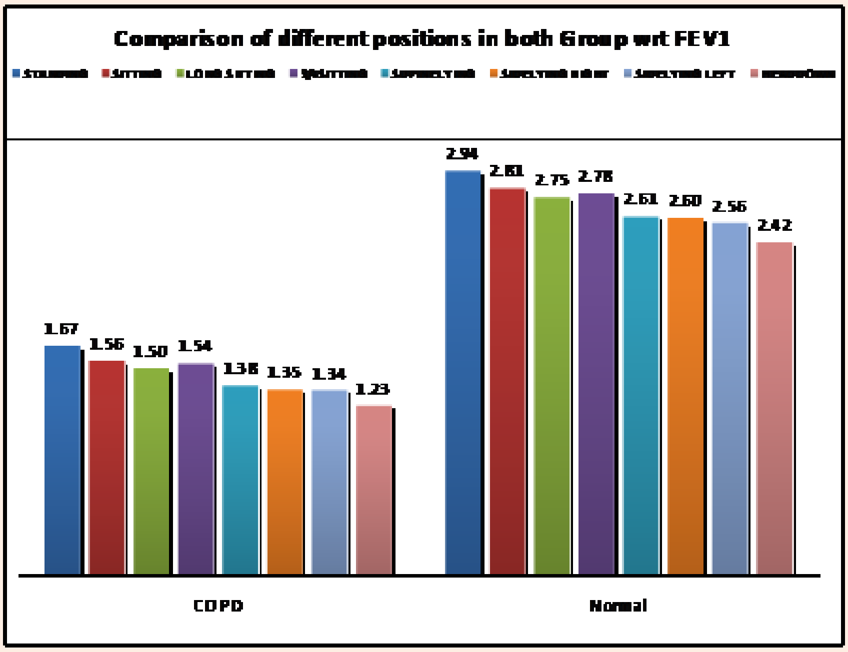
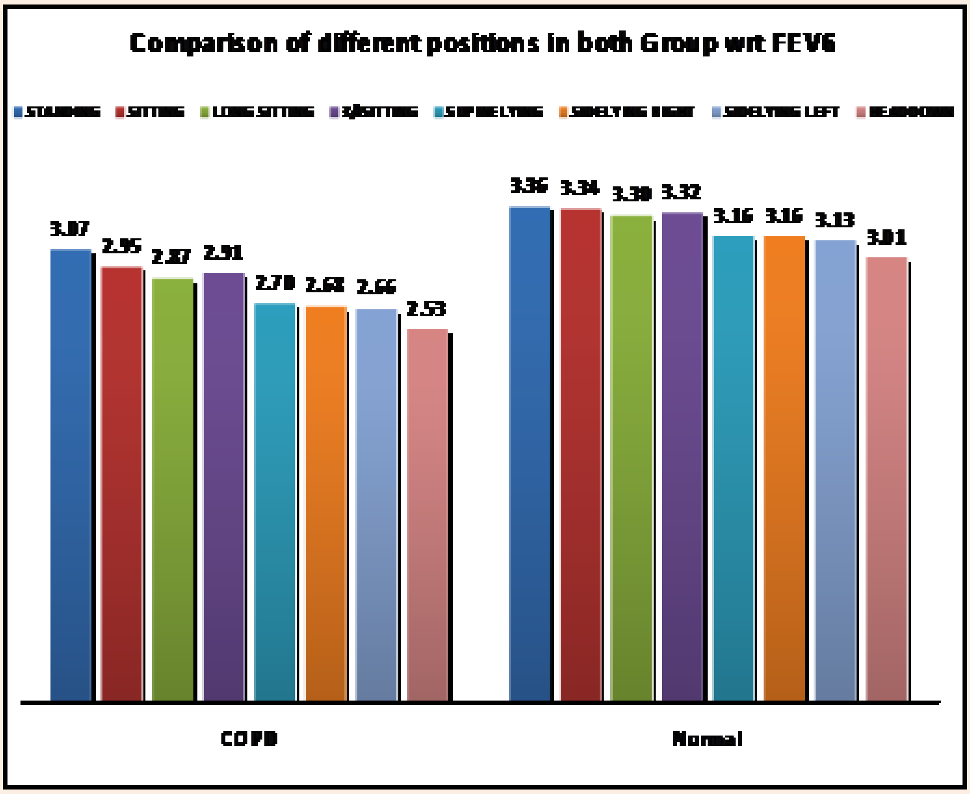


Graph 1: Graph for comparison of FEV_1 between COPD and Normal Subjects.



Graph 2: Graph for comparison of FEV_6 between COPD and Normal Subjects.

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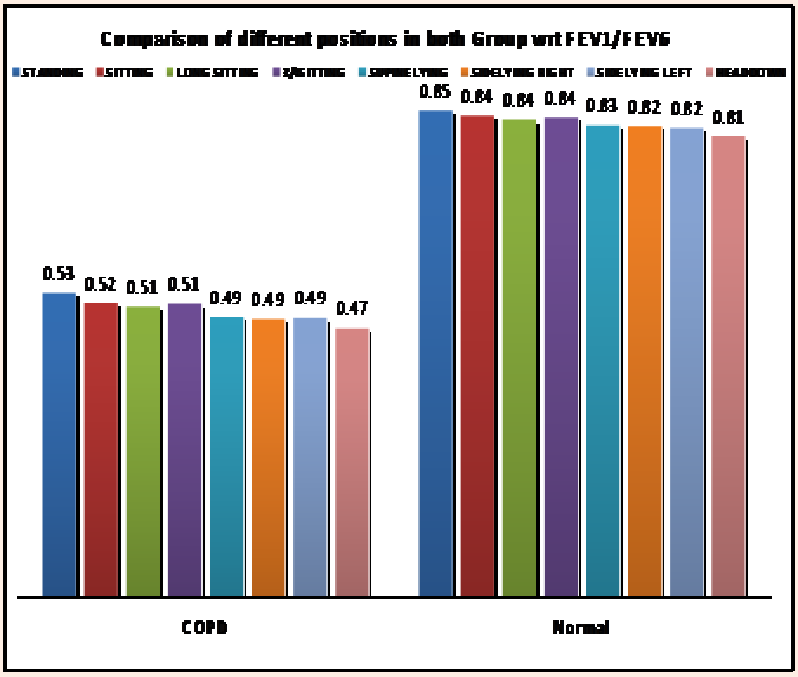
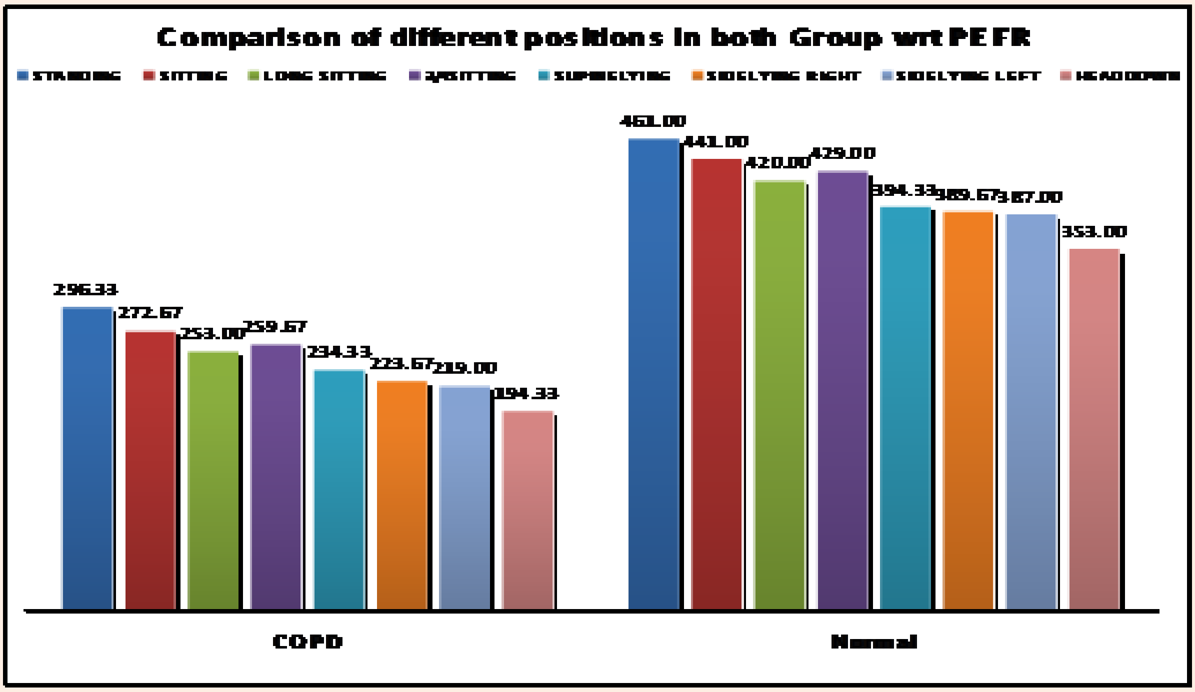


Graph 3: Graph for comparison of FEV_1/FEV_6 between COPD & Normal Subjects.



Graph 4: Graph for comparison of PEFR between COPD and Normal Subjects.

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Conclusion

Based on the analysis of data it can be interpreted that different body positioning produces significant effect on dynamic lung functions in COPD and normal subjects and can be therapeutically utilized by the COPD and normal subjects to perform expiratory maneuvers to promote secretion clearance and thus improving the general functional well being among themselves.

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