

ORIGINAL ARTICLE

IJPHY

TO FIND OUT THE EFFECT OF VARIOUS BODY POSITIONS ON PEAK EXPIRATORY FLOW RATE (PEFR) IN COPD PATIENTS

^{*1}Meghan Metha^{*2}Kiran Pawar

ABSTRACT

Background: COPD is the second most common lung disorder. Respiratory mechanics of COPD is altered. Lung volumes & biomechanical changes lead to weak & ineffective expiratory maneuvers.

Method: 40 COPD subjects above the age of 45years were selected through purposive sampling. The subjects were placed in seven different positions namely Standing, Chair sitting, Long sitting, Semi fowler's position, Supine, Side lying, Head down. Following this the subject performed three tests of PEFR with intermittent rest period as preferred by the subject between each trial.

Results: PEFR achieved by subjects with COPD were significantly affected by body position. Standing (161.82) led to results which were significantly higher than all other positions followed by chair sitting (150.079), long sitting (141.495), semi fowler's position (136.746), supine lying (126.829), side lying (120.162) and head low position (107.829) led to results which were significantly lower than all other positions.

Conclusion: More the upright position, higher the PEFR. PEFR is more in standing and Head down position has the lowest PEFR value. Increased lung volumes in standing position can be related to the increased thoracic cavity volume owing to the effect of gravity and the inspiratory muscles would be able to expand the unrestricted thorax in all directions in this position & expiratory muscles attain their optimal length during standing.

Keywords: COPD, PEFR, Dyspnoea, Body Positions, Airway clearance technique.

Received 15th March 2016, revised 31st March 2016, accepted 18th May 2016



www.ijphy.org

10.15621/ijphy/2016/v3i3/100830

CORRESPONDING AUTHOR

^{*1}Meghan Metha

Cardiorespiratory Physiotherapist,
Heart city branch, Kauvery hospital,
Trichy, Tamilnadu

^{*2}Physiotherapist,
MAEER'S college of physiotherapy,
Pune, Maharashtra, India.



INTRODUCTION

A chronic obstructive pulmonary disease (COPD) is defined by American Thoracic Society as a disease characterized by the presence of airflow obstruction that is attributed to either chronic bronchitis or emphysema. COPD is seen more commonly in older age above 35yrs of age. In India, COPD is the second most common lung disorder after pulmonary tuberculosis [1].

Patients with COPD presents with symptoms of chronic cough with expectoration, dyspnoea, labored breathing, plethoric or cyanotic appearance, weight loss, barrel chest, coarse rhonchi, wheeze and sputum[1].

The thorax appears enlarged due to loss of lung elastic recoil. The antero-posterior diameter of chest increases with dorsal kyphosis and it gives a patient barrel chest appearance. The thoracic excursion decreases. The diaphragm becomes flattened and there is hypertrophy of accessory muscles. Significant and progressive airway limitation increases the residual volume and functional residual capacity. Expiratory flow rate mainly FEV1 is decreased [2].

Respiratory mechanics of COPD patients is altered. Majority of these subjects are older and their secretion clearance is impaired. They also have altered muscle length-tension relationship thus there need to clear airway secretions is already compromised [3].

The essential component of defense mechanism of respiratory tract is adequate clearance of airway secretions. Respiratory complications like infections are commonly seen in patients predisposed to secretion retention [1].

There are different techniques to clear the airway secretions like Active Cycle of Breathing Techniques (ACBT); Postural Drainage (PD), etc. Different methods like humidification, nebulisation are also helpful in clearing the secretions. All these techniques include forced expiratory maneuvers [4].

Coughing and huffing are the forced expiratory techniques having high expiratory pressure and flow rates to aid with secretion clearance. Coughing is under voluntary control and it helps to remove secretions or the inhaled particles from the bronchial tree or pharynx [5].

Cough consist of contraction of the respiratory muscles against a closed glottis with resultant rise in intra thoracic pressure followed by opening of the glottis and forced expiration with very high flow rates in upper airway. In patients with severe airway obstruction, high rates of flow cannot be generated because of the airway narrowing. Huffing follows an inspiration and is a Sharpe expiratory maneuver where glottis remains open [6].

The Physiotherapist encourages the patient to cough and huff to clear the secretions and so to minimize complications. Performance of cough and huff is influenced by patients lung volumes, sensitivity of airway reflexes, muscle biomechanics, medications, pain, patients state of mind, etc. Higher lung volumes have been linked with better expiratory muscle length tension relationship and improved

expiratory pressure and flow rates. Body positions have been shown to affect lung volumes and muscle biomechanics. In COPD patients when secretion clearance is necessary, changes in lung volumes and biomechanics leads to weak and ineffective expiratory maneuvers [5]

Peak Expiratory Flow Rate (PEFR) have been used as surrogate measure of cough and huff strength. PEFR is defined as the maximal flow achieved during expiration delivered with a maximal force starting from maximal lung inflation. PEFR is determined by the size of lungs, lung elasticity, the dimensions and compliance of the central intrathoracic airways, the strength and speed of contraction of the respiratory muscles [7].

PEFR is highly effort dependant test but in practice it is very reproducible. High respiratory flow rate is required for the production of strong and effective expiratory maneuvers. PEFR is one of the convenient test and it measures the ease with which the lungs are ventilated. PEFR is influenced by lung volumes and muscle length tension relationship which is influenced by body positions. In this study PEFR is measured in seven different positions which are Standing, Sitting in chair, Long sitting, Semi fowler's position, Supine lying, Side lying (right side) and Head low (20 degrees) [8].

The results will be analyzed to see whether there is any effect of body positions on PEFR. So that by understanding how PEFR is affected by body positions , physiotherapists can advise their patients on positional changes that may help in maximizing the strength and efficiency of coughing and huffing providing better secretion clearance and preventing complications [4].

METHOD

A cross sectional study, involving 40 patients with COPD, coming to general hospital, Talegaon-Dabhade, who are not in acute exacerbation were selected using purposive sampling. Both male and female patients above 45years of age, who are diagnosed as having COPD by a chest physician were involved in the study. Patients with acute exacerbation or having any other respiratory disease, CVS disease, and rib fracture or neurological deficits were excluded from the study.

All the subjects participating in the procedure were informed with the proper details of apparatus and treatment protocol and informed consent taken, prior to undergoing the procedure. All subjects were given same instructions. Proper history was taken and detailed clinical examination was done all the contraindications were ruled out before enrolling the patient into the study.

Seven different positions were used in this study:

Standing: The subject adopted a comfortable stance [9].

Chair sitting: The subject sat in a plastic chair with armrest and was instructed not to slouch forward nor lean to either side [9].

Long sitting: The subject sat up straight on a padded plinth with legs straightened in front. The upper body makes a

90 degree angle to the leg. A wall supported the subject's upper body and pillow was placed behind the lumbar spine and below knee to increase comfort [9].

Semifowler's position: the subject was positioned on a padded plinth the top part of which was positioned at a 45 degrees angle. Pillow is given under knees. This means that the upper body makes an angle of 135 degrees with the legs [9].

Supine: The subject was positioned lying on his or her back on a padded plinth. The hips were flexed at a 45 degrees angle with the soles of the feet in contact with the plinth. This resulted in 90 degrees flexion of knees. A pillow was given under head [9].

Side lying: The subject was positioned lying on the right side on a padded plinth. The hips were flexed to 45 degrees and the knees were flexed to 90 degrees. A pillow was placed under the head [9].

Head down: The subject was positioned as for the side lying position on a padded tilt table. This was lowered, so that the subject's body was at a 20 degree angle, with the head lower than the feet [9].

Each subject was placed into the first randomly drawn position and allowed to rest for three minutes. Following this the subject perform three tests of PEFr with as much as rest as desired by the subject between each trial. Testing would be terminated if the subject withdrew consent, 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. The data used in analysis is the mean of the three values obtained in each position.



Figure 1: Standing



Figure 2: Chair Sitting



Figure 3: Long sitting



Figure 4: Semi fowler's Position



Figure 5: Supine Lying



Figure 6: Side Lying



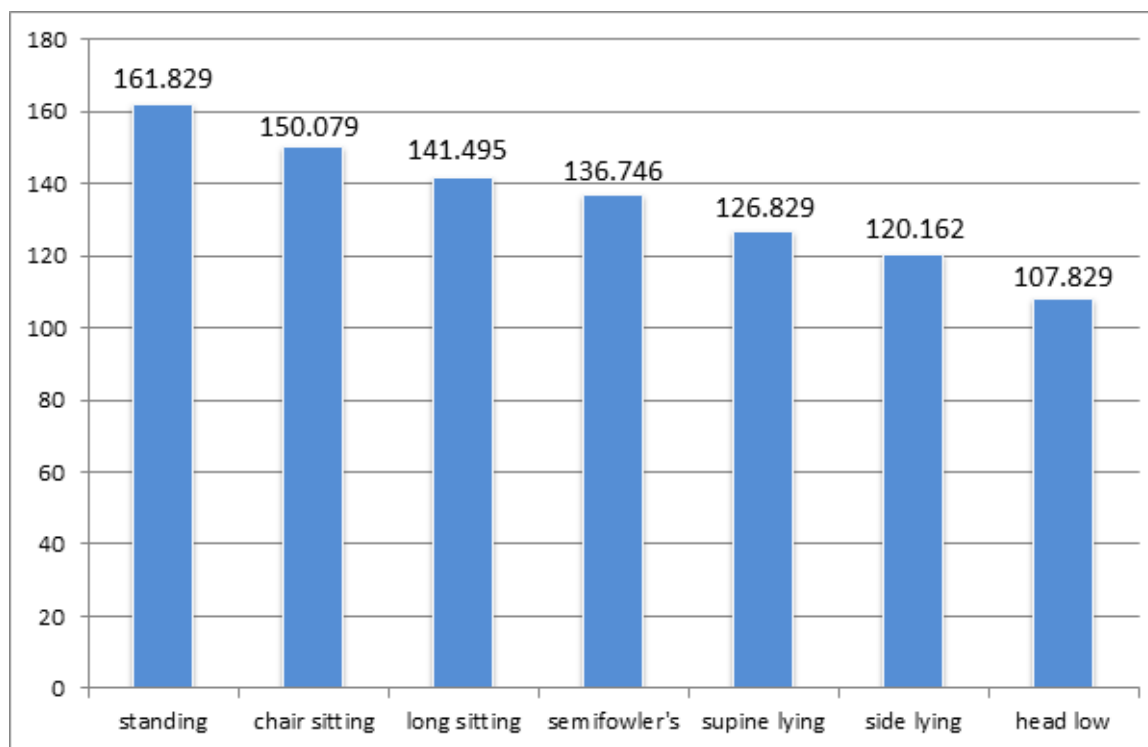
Figure 7: Head Low (20)

RESULTS

Peak expiratory flow rate achieved by subjects with COPD were significantly affected by body positions. Mean value of PEFr of all the participant in each position was calculated using standard deviation calculator. Standing (161.82) led to the results which were significantly higher than all other positions followed by chair sitting (150.079), long sitting (141.495), semi fowler's position (136.746), supine lying (126.829), side lying (120.162) and head low position

(107.829) led to results which were significantly lower than all other positions. Chair sitting, long sitting and lying positions led to better result than in head low.

Graph-1: PEFR values in various positions



DISCUSSION

PEFR values were significantly affected by Changes in body position in COPD subjects. A significant difference was observed in the mean PEFR values in all positions which can be attributed to pathology seen in COPD subjects (loss of lung elasticity, narrowed airways, and changed biomechanics of the thorax). Generally, as subject became more recumbent, the ability to generate PEFR is diminished. Conversely, as subject moved to less recumbent position, the expiratory flow rates improved. Secretion clearance is more effective with alteration in body position which may be especially useful for those patients demonstrating sub-optimal coughing and huffing [7].

Except for lung volumes, very little research exists on PEFR. Research on lung volumes was limited to body positions like chair sitting, supine and side lying. Most of the previous research has focused more on the inspiratory muscles than expiratory muscles.

The highest lung volumes were seen in Standing followed by upright sitting. An increased lung volume in standing position is assumed to be because of the increased thoracic cavity volume [9].

First, in standing the abdominal contents are pulled caudally within the abdominal cavity due to gravity, which increases the vertical diameter of the thorax. Second, unlike positions such as head down and supine, the weight of the heart & abdominal content does not compress the bases of the lungs. This causes reopening of compressed alveoli and leads to increase in lung compliance. Third, the thorax

remains unrestricted to expand in all directions by the inspiratory muscles. As a result, the diaphragm is able to contract even further caudally and thus increase lung volume. Increase in lung volume leads to more elastic recoiling of thoracic cage [9,10].

A larger amount of potential energy is stored in the tissue of the chest wall following a deep inspiration (as in preparation for maximal expiratory maneuvers). When the diaphragm contracts, it increases pressure on abdominal contents and push them forward which causes abdominal cavity to descend. This places slight stretch on abdominal muscles. At more stretched length; the abdominal muscles are more capable of stronger contractions and thus generates higher PEFR. In standing, the expiratory muscles attain their optimal length [11].

In standing the recoiling of the lungs and chest wall is combined with higher pressures generated by abdominal contraction during a forced expiration. This combined action pushes the air at high speeds through narrowing airways resulting in the higher PEFR. Other factors like patients comfort & higher arousal level might influence the results in the standing position [9,11].

Chair sitting led to the second highest lung volume results after standing. This might be because of slightly lesser inspirations by the subject than in the standing position as the abdominal contents are higher in the abdominal cavity that interfere with movements of the diaphragm. The hip flexion required in chair sitting and the higher position of the abdominal contents may be implicated in a less optimal

abdominal muscle length. Further, when the subject is sitting, the thoracic expansion might get limited by the back of the chair. Thus, lower lung volumes & PEFr value might be due to limited thoracic cavity capacity in the sitting position [9,12].

The explanation for the results of PEFr changes in long sitting and semi fowler's position is similar as for chair sitting as the values of chair sitting, long sitting and semi fowler's position does not differ significantly [13].

No much difference was seen in the comparison of side lying and supine lying. Previous research has shown only small changes in total lung capacity between these two positions. Though in side lying position, the abdominal muscles are at better length than in supine as the abdominal contents moves forward, the thoracic volume is decreased as the bed limits the expansion of one hemi thorax. This may result in slightly lower lung volumes and less elastic recoil than in the supine position.⁽¹⁴⁾

The results in supine and side lying were similar to those in long sitting and semi fowler's position. A previous research on lung volume has shown that the more upright position leads to higher lung volumes and thus higher PEFr. Whereas two extreme positions show large difference as found in the results. The differences in the mid ranges may be compensated for or may be very small [9].

The lowest mean PEFr was found in head down position. Clinically, head low position is not used much, only in specific situations like gravity assisted drainage of the basal segments of the lungs. One more reason for the diminished performance in this position is lack of practice of this position. In everyday lives people with COPD does not use head low position for coughing & huffing. Some subjects in this study stated that they felt "strange" and "uncomfortable" in the head down position. This may further limit their capacity/performance in this position [15,16].

One should consider the biomechanics of the side lying subject in the head down position. Compared to the side lying with the bed flat, in the head down position some of the abdominal contents tends to descend in thoracic cavity. This reduces lung volumes further, by decreasing the diaphragm ability to be flattened. However one of the possible advantages of this position is, as the abdominal content pushes the diaphragm into the thoracic cavity the diaphragmatic fibers are stretched to a better length. However the effect of such diaphragmatic excursion on lung volumes is still unclear, partly because of the lack of research on this position [9,17].

The PEFr changes across some of the positions may have clinically significant implications. This is best illustrated when comparing the extremes. For PEFr the change is 33.37% for the subjects with COPD. Smaller changes, of the order of 7-10%, are seen when other positions are compared. Even changes of as little as 7% may offer a clinically significant benefit. Airway clearance will be more effective if secretion clearance techniques like coughing & huffing are given in a position having optimal PEFr value.

When patient's secretion clearance capacity improves, there is less obstruction to ventilation. So that the subject is able to achieve higher lung volumes and produce even higher PEFr that will further enhance secretion clearance. Also, by clearing secretions which gives the patient difficulty, he or she may feel better, hence increases confidence in the treatment, and make them more compliant to the therapy [18].

CONCLUSION & CLINICAL SIGNIFICANCE

Body position has an effect on PEFr generated by COPD subjects. Higher PEFr values were found with more upright position. PEFr is more in standing followed by upright sitting, then semifowler's position and lying down. Head down position has the lowest PEFr value. This data suggest that patient should attain most upright position when clearing the secretions from larger airways. Changing to a better position may be especially useful for those patients with weak expiration.

Different techniques of airway clearance like active cycle of breathing techniques (ACBT), autogenic drainage, postural drainage (PD), chest clapping, vibrations, shaking can be given which is followed by coughing or huffing. So coughing can be given in the position which optimizes PEFr.

Limitations of the study

- The large number of COPD patients should be involved.
- Some more positions can be given eg. Prone lying, left side lying.
- This study can be conducted for other group of patients like patients with chest wall surgeries, upper abdominal surgery, following spinal cord lesion, bronchiectasis, etc.

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Citation

Metha, M., & Pawar, K. (2016). TO FIND OUT THE EFFECT OF VARIOUS BODY POSITIONS ON PEAK EXPIRATORY FLOW RATE (PEFR) IN COPD PATIENTS. *International Journal of Physiotherapy*, 3(3), 291-296.