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"Stages of Relief" - Effect of Active Cycle of Breathing Technique (ACBT) on Chronic Obstructive Pulmonary Disease (COPD) Patients in Different Stages of Disease Severity

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is an umbrella term for lung conditions such as emphysema and chronic bronchitis, and the symptoms of individuals with these conditions such as breathing difficulties, wheezing, cough, and mucus production often exaggerate during flare-ups. The usefulness of Active Cycle of Breathing Technique (ACBT) for individuals with flare-ups of COPD or stable COPD is still difficult to determine. The purpose of this study was to explore the effect of active cycle of breathing technique (ACBT) on pulmonary functions among the patients with mild, moderate, and severe stages of chronic obstructive pulmonary disease (COPD).

Methods: It was a cross sectional, single-centre study. 60 patients of COPD were recruited based on convenient sampling. The patients were diagnosed by chest physicians and were categorized into mild (n=17), moderate (n=20) and severe (n=23) stages as per the GOLD (Global Initiative for Chronic Obstructive Lung Disease) criteria based on Pulmonary Function Tests (PFT). ACBT along with conventional physiotherapy treatment was provided to all the patients in all three groups once daily for one week. PFT was carried out before and after the intervention. Paired t-test was carried out for the comparison of PFT values, before and after intervention. One-way ANOVA was performed for comparison of PFT values between three groups.

Results: The results show improvement in all parameters that is, Forced Expiratory Volume in One second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC after the intervention among patients with mild COPD and showed improvement in FEV1 and FVC among patients with moderate and severe COPD ($p<0.05$). While comparing the improvement among three groups, no statistically significant difference was found for all the parameters.

Conclusion: This study suggests that ACBT is effective in reducing airway obstruction at all stages of COPD, however, it is more effective among patients with mild category.

Keywords: Chronic Obstructive Pulmonary Disease (COPD), Airway obstruction,

Cough, Mucus, Active Cycle of Breathing Technique (ACBT), Respiratory function tests, Physical therapy modalities

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a partially reversible chronic airflow obstruction which interferes with normal breathing. It is a serious lung illness that goes undiagnosed and can be fatal, not just a "smoker's cough". [1, 2]

COPD has remained largely unrecognized as a public health problem and is predicted to become the third leading cause of death worldwide by 2030.[3]

The increasing burden of COPD is a particular risk to countries with developing health systems. Lung function continues to deteriorate during the disease's protracted asymptomatic period. The illness advances slowly. One typical symptom is persistent cough, especially when there is mucus production. Dyspnea, especially with activities, wheezing, and chest tightness may also be present. Patients frequently arrive at an advanced stage of COPD with their initial severe exacerbation. Symptoms do not usually occur until forced expiratory volume in 1 second (FEV_1) is approximately 50% of the predicted normal value.[4]

As part of the usual examination of systems, screening for the history of smoking, cough, sputum, dyspnea, and exposures should be done. If any of these findings are found, more evaluation may be necessary. Spirometric measurements can be used to classify the severity of COPD, as established by GOLD.[5]

Multidisciplinary efforts involving government, healthcare workers, and public health officials are needed to reduce the disease burden, which comprises not only economic and healthcare system costs but also losses to patients and families from progressive disability and impaired quality of life.

Apart from managing the disease with pharmacotherapy and smoking cessation, physiotherapy and rehabilitation are one of the major non-pharmacological modes of dealing with COPD.

Physiotherapy in COPD includes various maneuvers for managing breathlessness, energy conservation, improving ventilation and oxygenation, breathing techniques, ventilation feedback training, managing anxiety and panic, respiratory muscle training, use of IPPV (Intermittent Positive Pressure Ventilation), NIV (Non-Invasive Ventilation), oxygen therapy, pelvic floor muscle training, and largely the Airway Clearance Techniques (ACTs).[6]

FETs (Forced Expiratory Techniques) including Active Cycle of Breathing Technique (ACBT) are commonly used to enhance bronchial hygiene and promote airway clearance in patients with chronic lung diseases.[7]

Excessive mucus production further leads to airway obstruction, infection, and inflammation. Treatment strategies which target the airway clearance may help in reducing the frequency of infections and exacerbation, thereby preventing further airway obstruction, deterioration of lung function, and potentially reducing the rate of progression of lung disease.[8]

A cycle of ACBT typically includes Thoracic Expansion Exercises (TEEs) in conjunction with FET. The whole cycle is interspersed with breathing control (BC). The FET includes 3-4 huffs at various lung volumes followed by a strong cough which ultimately removes the secretions from central airways. Various phases/components of this cycle vary regarding the number of repetitions and frequency based on the individual needs of the patient, making sure to incorporate all without missing any single one.[7]

COPD is an umbrella term for lung conditions such as emphysema and chronic bronchitis, and the symptoms of patients with these chronic conditions such as breathing difficulties, wheezing, and cough with expectoration often get worsened during flare-ups.[9] The usefulness of ACBT for individuals with flare-ups of COPD or stable COPD is still difficult to ascertain[10]

and therefore, the present study has been undertaken to identify the effectiveness of ACBT on airway obstruction and to compare the same among the patients with different stages of chronic obstructive pulmonary disease (COPD) in terms of pulmonary function tests.

MATERIALS & METHODS

It was a single-centre, experimental study. The study was approved by the institutional ethics committee. Written informed consent was obtained from all the study participants. The patients were diagnosed with COPD by the chest physician of the hospital based on PFT. Based on inclusion and exclusion criteria, a total of 60 patients with confirmed diagnosis of COPD were enrolled with convenient sampling, and were divided into three groups: Mild (n=17, 28.3%), Moderate (n=20, 33.3%) and Severe (n=23, 38.3%) COPD as per GOLD criteria. All the patients were males, had a history of smoking and were on medication.

Inclusion criteria:

- Patients with a confirmed diagnosis of COPD based on PFT and on regular medications
- Both males and females

Exclusion criteria:

- Patients with very severe airway obstruction (FEV_1 < 30% predicted)
- Patients with any other respiratory or cardiovascular disorders, neurological disorders, and musculoskeletal problems viz. Rib fracture, osteoporosis of ribs, etc.
- Patients with acute exacerbation of COPD and severe hemoptysis
- Patients who are non-cooperative
- Patients with recent abdominal surgeries or neurosurgeries

All the patients were assessed for history, demographic details, and detailed physical examination of the respiratory system including PFT (FEV_1, FVC, FEV_1/FVC). Mean age of the patients was 57.18 $\pm$ 2.38 years, ranging from 50 to 60 years and had a mean BMI of 23.04 $\pm$ 1.79 kilogram/meter^2(kg/m^2).

Patients in all three groups were provided with conventional physiotherapy treatment along with ACBT, once a day for a total of one week. The conventional physiotherapy treatment included breathlessness relieving positions, pursed lip and diaphragmatic breathing exercises, huffing and coughing, and tailor-made endurance training including AROM (Active Range of Motion) exercises, bed mobility, bedside and out of bed mobilization, etc.

ACBT included all three components i.e. breathing control, thoracic expansion exercises which include deep breathing exercises emphasizing inspiration with a 3-second hold before the passive relaxed expiration, and forced expiratory technique with short huffs followed by a cough from high lung volume.

All the patients were reassessed for PFT at the end of one week of intervention.

STATISTICAL ANALYSIS

Statistical analysis was carried out using Stata 14.2 software (©copyright 1985-2015 StataCorp LLC, StataCorp, 4905 Lakeway Drive, College Station, Texas 77845 USA). Paired t-test was used for comparison of PFT before and after the intervention in each group. The change noted in PFT after the intervention was compared between all three groups with one-way ANOVA *($p<0.05$)*.

RESULT

All the patients were divided into three groups: mild, moderate, and severe COPD based PFT findings and GOLD criteria. All of them were assessed for PFT including FEV_1, FVC, and FEV_1/FVC before and after the intervention.

Comparison of PFT values before and after the intervention in each group (Table 1) shows significant improvement in all three parameters (FEV_1, FVC and FEV_1/FVC) among patients with mild COPD, however, patients with moderate and severe COPD

had statistically significant improvement in FEV_1 and FVC *($p<0.05$)*.

While comparing the difference in improvement in PFT among three groups (Table 2), no statistical difference was found, however, the highest improvement was noted among patients with mild COPD followed by moderate and severe COPD.

Table 1 Comparison of Forced Expiratory Volume in One second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC before and after the intervention in each group.

	Mild COPD (n=17)			Moderate COPD (n=20)			Severe COPS (n=23)		
	Mean	**SD**	***p value***	**Mean**	**SD**	***p value***	**Mean**	**SD**	***p value***
FEV_1 Before intervention	75.30	7.22	0.000*	51.14	5.95	0.000*	33.49	7.34	0.003*
FEV_1 After intervention	80.40	6.93		54.57	7.47		35.76	7.85	
FVC Before intervention	100.02	16.47	0.000*	78.70	14.80	0.011*	54.28	11.42	0.000*
FVC After intervention	102.91	16.35		83.18	15.00		58.19	10.81	
FEV_1/FVC Before intervention	0.76	0.09	0.012*	0.66	0.78	0.641	0.62	0.13	0.762
FEV_1/FVC After intervention	0.79	0.11		0.66	0.81		0.62	0.15	

P<0.05

SD- Standard Deviation, FEV_1- Forced Expiratory Volume in 1 second, FVC- Forced Vital Capacity

Table 2 Difference in PFT values before and after intervention in all three groups

	Stages of COPD	**N**	**Mean**	**SD**	***p value***
Difference in FEV_1	Mild	17	5.1000	4.32464	0.054
	Moderate	20	3.4350	3.20415	
	Severe	23	2.2696	3.26779	
	Total	60	3.4600	3.69779	
Difference in FVC	Mild	17	2.8824	2.20546	0.621
	Moderate	20	4.4800	7.10853	
	Severe	23	3.9087	4.12100	
	Total	60	3.8083	4.93237	
Difference in FEV_1/FVC	Mild	17	0.030600	0.0447614	0.052
	Moderate	20	0.004234	0.0399557	
	Severe	23	0.002857	0.0446863	
	Total	60	0.008986	0.0447101	

P<0.05

SD- Standard Deviation, FEV_1- Forced Expiratory Volume in 1 second, FVC- Forced Vital Capacity

DISCUSSION

Chronic obstructive pulmonary disease (COPD) is characterized by frequent exacerbations, resulting in increased cough with sputum production mainly due to ciliary dysfunction and mucus hyper-secretion. In normal healthy individuals, the optimal function of the respiratory system is maintained by the mucociliary escalator and cough reflex which helps in removing secretions and preventing airways obstruction. A variety of factors including aging, smoking, tobacco chewing, exposure to dust and other allergens, etc. interfere with this natural defense mechanism and reduce the efficacy of this mucociliary escalator, making the sputum/secretions difficult to be mobilized and evacuated from the airways. Frequent retention of secretions leads to recurrent inflammation and infection, resulting in airway obstruction and structural damage to the airways and lung parenchyma. This mucociliary transport mechanism does not fully recover in patients with COPD due to its progressive nature.[11]

Increased sputum production is a common symptom of acute exacerbations of COPD

(AECOPD) which promptly requires early therapy to reduce its overall detrimental effect on disease outcome. As per the guidelines published by the American Association of Respiratory Care (AARC), it is very important to maintain the bronchial hygiene for patients hospitalized for COPD to help them with mucosal drainage and restoring healthy lungs. Considerable global variations are there regarding clinical practice of ACTs for patients with COPD. Manual techniques composed of postural drainage, clapping, percussion, and vibration are traditional means of airway clearance.[12]

Use of various ACTs has been reported in literature such as positioning, breathing exercises, positive expiratory pressure (PEP) therapy, mechanical chest wall oscillations, etc. Choice of these techniques is the most critical area and has to be determined judiciously by the physical therapists as per the individual consideration of patients' needs. The variability with regards to use of these techniques and treatment regimens is well documented due to lack of standardized recommendations within and between countries. The new initiatives or the ideas to strengthen the variability in use of conventional practices are not always open for discussion. The most used ACTs by therapists among various countries from the United Kingdom (UK), Canada and Australia, where healthcare systems are very similar, were the active cycle of breathing technique (ACBT), postural drainage, percussion and vibration, and physical exercise, respectively. So, it is difficult to determine the effectiveness of the implication of these findings in current clinical practices as the studies were carried out more than a decade ago, which might have changed since then.[13]

In literature, the effects of ACBT in COPD patients have shown mixed results. A systematic review, to study the effect of ACBT in patients with COPD concluded that ACBT can effectively improve the sputum production and cough efficiency in patients with COPD, however, there was no definite reasoning on its effectiveness on lung functions and blood gas analysis.[12] The level of evidence reported in literature is grade "B" for use of ACBT in patients with COPD among various non-pharmacologic airway clearance therapies.[14]

In the present study, patients in all three groups had improved PFT after the intervention, however maximum improvement was noted among patients with mild category COPD. This can be attributed to the severity of parenchymal and alveolar damage as the disease progresses making the ACT relatively less effective compared to mild and moderate disease.

The frequency of exacerbations and the respiratory symptoms, and the rate of decline in lung functions widely vary among the patients with different stages of COPD. The presence of airflow limitation which results from airway inflammation and remodeling is often associated with parenchymal destruction, which increases over a period leading to an increase in the symptoms mainly breathlessness and cough with expectoration. [15, 16]

Several mechanisms have been explained for ACBT by which it enhances bronchial hygiene and airway clearance; thus, leading to reduction in parenchymal destruction and airway obstruction. The breathing control (BC) in ACBT prevents bronchospasm and improves oxygen saturation. The TEEs along with chest vibrations aid in the loosening and clearance of secretions, while the end-inspiratory hold for a few seconds helps to improve collateral ventilation. The forced expiratory manoeuvres including huffing (low, mid and high lung volume) and coughing are thought to promote secretion movement from distal smaller airways to the larger and more proximal ones by alteration in thoracic pressures and airway dynamics. It is possible that, depending on the severity and the stages of disease, the severity of respiratory symptoms, the degree of sputum production

and the condition of patients with regard to presence of exacerbations, the physiological effects of ACBT may vary rather across the patient population. ACTs techniques like ACBT have demonstrated significant positive and favourable outcomes in patients with a wide range of lung diseases, including COPD, bronchiectasis, and cystic fibrosis.[17]

CONCLUSION

The present study proves the definite role of ACBT in reducing airway obstruction among patients with all the stages of COPD and it must be incorporated during regular chest physiotherapy sessions irrespective of the severity of disease.

Declaration by Authors

Ethical Approval: The research work has been approved by the institutional ethics committee.

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