Original Article

Pulmonary Rehabilitation on Small Airways Function in COPD Patients

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Abstract

Background: The importance of pulmonary rehabilitation (PR) is known to be therapeutically useful for COPD patients.

Objective: To evaluate the effects of PR program of pursed lip breathing (PLB) and diaphragmatic breathing (DB) on $FEF_{25-75\%}$ and $FEF_{50\%}$ in male patients with moderate stable COPD.

Methods: This prospective study was conducted in the Department of Physiology, BSMMU, Dhaka from July 2010 to June 2011 on 116 male stable moderate COPD patients aged 50 to 65 years. They were enrolled from the outpatient department (OPD) of the Department of Medicine of BSMMU and NIDCH Dhaka. All the patients were grouped as control (56 patients without PR) and experimental (60 patients with PR). The experimental patients were advised to perform the PR program for 30 minutes duration per session at home twice daily, for consecutive 60 days along with the standard drug treatment of COPD. The control patients were advised to continue their standard drug treatment alone for consecutive 60 days. For the assessment of small airways function status, $FEF_{25-75\%}$ and $FEF_{50\%}$ were recorded of all the subjects on day 0 and day 60 for both the groups by a portable digital MicroDL Spirometer and the statistical analysis was done by independent sample 't' test and paired Student's 't' test.

Results: Significant improvement were observed in $FEF_{25-75\%}$ and $FEF_{50\%}$ in patients who performed PR program.

Conclusion: The study concludes the improvement of small airways function with this sort of combination of PR program in stable COPD patients.

Key words: Pulmonary rehabilitation, COPD, Spirometry, $FEF_{25-75\%}$, $FEF_{50\%}$

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is one of the major causes of chronic morbidity and mortality throughout the world.[1] It is the fourth leading cause of death in adults of United States and also projected to be the third by 2020.[2] According to Global Initiative for Chronic Obstructive Lung Disease COPD is a preventable and treatable disease. However, once developed this disease along with its comorbidities can not be cured, though its progression and morbidity can be reduced.[1]

The pulmonary component of COPD is characterized by airflow limitation caused by a mixture of small airways disease (obstructive bronchiolitis) and parenchymal destruction (emphysema). In addition, chronic inflammation causes structural changes and narrowing of the small airways with subsequent decrement in ventilation.[1]

Spirometry has been suggested as the method of assessing lung function by measuring the volume of air that a person can expel from the lungs after a maximal inspiration.[3] Again, GOLD (2008) stated that spirometry is the best way of making a definitive diagnosis of COPD.[1] Although spirometry does not fully capture the impact of COPD on a patient's health, it remains the gold standard for diagnosing the disease and monitoring its progression.[1] It has also been proposed as the best standardized, most reproducible and most objective measurement within the available maneuver for any airflow limitation.[1] It has been suggested by different investigators abroad that, the ventilatory function of the lung such as $FEF_{25-75\%}$ and $FEF_{50\%}$ can be assessed by spirometry.[4]

PR is an evidence-based, multidisciplinary and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities.[5] According to GOLD standard, PR aims to reduce the symptoms, to improve quality of life, and to increase the physical and emotional participation of COPD patients in everyday activities.[1] The minimum length of an effective rehabilitation program has been suggested as 6 (six) weeks.[1]

Medicines might have a limited role in improving these ventilatory variables in COPD patients. Breathing exercises (pursed lip breathing and diaphragmatic breathing) as component of PR have been found to improve ventilatory variables. Home based PR has been advocated to patients for its various advantages.[6]

In different prospective studies abroad improvement in $FEF_{25-75\%}$ and $FEF_{50\%}$ were found by different investigators in patients with stable COPD both before and after administration of different components of PR program such as breathing strategies.[7]

However, with the best of our knowledge no study has yet been done in Bangladesh to observe the effects of combination of more than one component of PR program on small airways function in stable COPD patients. Therefore, on the basis of this background, the present study has been designed to evaluate the effects of PR program such as PLB and DB on small airways function in male patients with moderate stable COPD.

Methods

This prospective study with exercise intervention was carried out in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka from July 2010 to June 2011. The study protocol was approved by Ethical Review Committee (ERC) of BSMMU. A total number of 116 male stable (without any exacerbation for last 4 weeks[8]) moderate COPD (Postbronchodilator FEV_1/ FVC < 0.70 and FEV_1 < 80% but > 50% of predicted[1]) patients aged 50 to 65 years were selected from the Medicine OPD (Respiratory medicine unit) of BSMMU and the Department of Medicine of National Institute of Diseases of the Chest and Hospital (NIDCH) Mohakhali, Dhaka by systematic random sampling. 56 patients without PR served as control and 60 patients with PR served as experimental. They were assessed on day 0 and on day 60. Subjects with the history of bronchial asthma, bronchiectasis, respiratory failure, pneumothorax, pleural effusion, pulmonary tuberculosis, pulmonary fibrosis, pneumonectomy or pulmonary lobectomy etc[9] any cardiovascular diseases[9], diabetes mellitus (Fasting plasma glucose >7 mmol/dl[10]), irritable bowel syndrome[11], SLE[12], systemic hypertension (SBP > 140 and DBP > 90 mm of Hg[13]), any malignancy or renal disease (Serum creatinine >1.36 mg/dl[14]), were excluded from the study. PR program included PLB and DB for 30 minutes duration per session and were performed at home twice daily, for consecutive 60 days along with the standard drug treatment of COPD. In the technique of PLB, patients inhaled through the nose with mouth closed, and then exhaled through mouth with lips pursed tightly.[6] The exhalation was twice as long as the inhalation. In the technique of DB, the patients were asked to exhale slowly through pursed lips while drawing the abdomen inward, and inhale slowly through the nose so that the abdomen would expand outward.[6]

After selection, all the patients were thoroughly informed about the aims, objectives and procedure of the study and were encouraged for their voluntary participation. Then an informed written consent was taken from each subject. A detail personal, medical, family, socioeconomic, occupational and drug history were recorded in a preformed data schedule and thorough physical examinations were done and documented. For the assessment of small airways function status, $FEF_{25-75\%}$ and $FEF_{50\%}$ of all subjects were recorded by a portable digital MicroDL Spirometer. $FEF_{25-75\%}$ and $FEF_{50\%}$ were measured in both the groups, on the first day of the study and also at 60^{th} days. Data were expressed as mean ± SD of percentage of the predicted value (% PV) and were statistically analyzed

by SPSS (Version 16.0) using independent sample 't' test and paired student's 't' test, as applicable. In the interpretation of results, $p<0.05$ was accepted, as level of significance.

Results

All of the participants were similar in respect of age, height, duration of COPD, duration of smoking, socioeconomic status and occupation. (Table I)

After 60 days follow up, mean $FEF_{25-75\%}$ and $FEF_{50\%}$ were decreased in the group without PR and increased in the group with PR but the increment was statistically significant and the decrement of mean $FEF_{25-75\%}$ in the group without PR was statistically significant. (Table II)

Table I: Socio demographic characteristics of different groups (n=116)

Parameters	COPD patient without PR (n=56)	COPD patient with PR (n=60)
Age (years)	58.91±4.05 (50-65)	58.58±4.12 (50-65)
Height (meters)	1.655±0.03 (1.58-1.72)	1.651±0.03 (1.57-1.71)
Duration of COPD (years)	3.04±1.12 (0.5-5)	3.41±1.22 (1-5)
Duration of smoking (pack years)	15.41±4.16 (11-25)	16.80±4.38 (11-25)
Socioeconomic statue (score)	1.63±0.78 (1-4)	1.88±0.83 (1-4)
Occupation (score)	2.04±1.06 (1-4)	2.37±1.06 (1-4)

Data were expressed as mean±SD. Figures in parentheses indicate ranges. Statistical analysis was done with independent sample 't' test and Chi-square test (χ^2).

Table II: $FEF_{25-75\%}$ and $FEF_{50\%}$ in different groups with different duration (n=116)

Parameters	COPD patient without PR (n=56)		COPD patient with PR (n=60)	
$FEF_{25-75\%}$	23.84±5.19 (16-37)	22.93±5.11# (17-36)	22.87±6.46 (16-37)	24.83±6.71### (17-40)
$FEF_{50\%}$	25.20±6.02 (17-41)	24.80±6.33 (17-40)	23.67±6.24 (15-38)	25.22±7.06## (16-40)

Data were expressed as mean±SD of % of PV. Statistical analysis was done by unpaired and paired student's 't' test. #: Day 0 vs Day 60 (#: $p<0.05$; ##: $p<0.01$; ###: $p<0.001$).

Discussion:

The present study shows significant improvement of $FEF_{25-75\%}$ and $FEF_{50\%}$ in pulmonary rehabilitated COPD patients after 60 days of follow up. Similar observation were reported by several investigators.[7] On the other hand, $FEF_{25-75\%}$ and $FEF_{50\%}$ were decreased in both the groups without PR but the decrement of $FEF_{25-75\%}$ was statistically significant. However, no similar observation was available for comparison.

From our study, the exact mechanisms of the benefit of PR program on ventilatory functions in stable COPD patients could not be elucidated. It has been suggested that long standing alveolar hypoventilation and dyspnea in the COPD patients may cause increased work of breathing, hypoxia induced decreased ATP production and increased energy expenditure followed by negative nitrogen balance may cause decreased protein synthesis, which might be an important contributory factor for the genesis of respiratory muscle wasting.[15-17] On the other hand, expiratory airflow limitation due to decrease elastic fibres in the alveolar walls and airways have also been suggested as an important contributory factor for lung hyperinflation in this group of patients. As a consequence, there may be increase in inspiratory airflow resistance followed by derangement of ventilatory variables.[18,19] In addition, the decrement in elastic fibres in the chest wall may also produces chest wall deformity and mechanical derangement in ventilation in COPD patients to cause additional obstacle for ventilation.[9] All of these above mentioned factors might be the cause of decrement in overall skeletal muscle mass in the stable COPD patients of our study which may produce their respiratory dysfunction and alteration in the ventilatory variables.

The first component of PR program that is, regular PLB has been suggested to decrease the amount of the trapped air in the lungs followed by decreased work of breathing[20] as well as relief of dyspnea[20,21] and increase in $SpO_{2\%}$.[22] Moreover, regular DB (another important component of PR program) along with PLB have also been proposed to be a cause of strengthening of the diaphragm and abdominal muscles followed by decrement in energy utilization for breathing.[23] As a consequence, coordinated movement of the diaphragm during respiration may produce improvement of the ventilatory variables ($FEF_{25-75\%}$ and $FEF_{50\%}$) in this study.

Conclusion

From this study, it may be concluded that small airways function were improved after regular PR program in male patients with moderate stable COPD.

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