

# Effect of pulmonary rehabilitation on the exercise capacity in COPD patients

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## Abstract

**Background:** COPD is the fourth leading cause of death worldwide. Several studies have reported that a low body weight and weight loss were negatively associated with quality of life and survival in COPD. Present study was conducted for a period of 6 weeks for analysis to see if the benefits of the pulmonary rehabilitation on exercise capacity of COPD patients could be obtained at less cost and time to both medical team and COPD patients. This study was conducted in the department of Physiology, Maulana Azad Medical College and the department of Medicine, Lok Nayak Hospital, New Delhi. Exercise parameters like 6Minute Walk Test duration, Hand Grip Test and Bicycle Ergometer Endurance time duration improved significantly after 6 weeks of pulmonary rehabilitation. **Methods:** This study was conducted in the physiology department MAMC. Spirometry was performed in 30 patients, both males and females suspected of having COPD. After fulfilling the inclusion and exclusion criteria of our study, all patients were finally subjected to pulmonary rehabilitation. After the completion of 6 weeks of pulmonary rehabilitation comparison between different exercise parameters both pre and post pulmonary rehabilitation were done. **Results:** Data collected from the study group was analyzed with statistical software package, SPSS using the student paired t-test, showed that there was significant improvements in terms of Exercise and its related parameters like 6-MWT (p-value< 0.001), HGT (p-value< 0.001), ET (p-value< 0.001) after pulmonary rehabilitation. **Conclusion:** After 6 weeks of pulmonary rehabilitation there was significant improvement in exercise parameters like 6-MWT, HGT, Bicycle ergometer Endurance Time.

**Key words:** COPD, Pulmonary rehabilitation, 6MWT, hand grip.

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## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable disease state characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking. Although COPD affects the lungs, it also produces

significant systemic consequences. COPD is defined by American Thoracic Society as chronic, slowly progressive disorder characterized by airflow obstruction (reduced FEV1 and FEV1 / FVC ratio) that does not change markedly over several months of observation<sup>1</sup>. Several other associated conditions such as increased systemic inflammation in early stages of COPD, risk for future exacerbations, cardiovascular diseases, weight loss, loss of fat-free mass combined with muscle dysfunction, osteoporosis, hypoxemia and depression<sup>2-4</sup> add to the morbidity and lead to reduced physical performance in these patients.

There are tests available to assess the functional exercise capacity in COPD patients. These are cardio-pulmonary exercise test like Bicycle Ergometry- Endurance Time, Test and Hand Grip Test, 6-Minute Walk<sup>5</sup>.

Pulmonary rehabilitation programmes aim at improving exercise capacity, activities of daily living, quality of life and perhaps survival in COPD patients. Pulmonary rehabilitation is defined as a “multi-disciplinary program

of care for patients with chronic respiratory impairment that is individually tailored and designed to optimize physical and social performance and autonomy.” Pulmonary rehabilitation includes smoking cessation, optimal medical treatment, exercise training, nutritional intervention, psychosocial support, health education and breathing exercises<sup>6</sup>. Well-designed studies investigated and confirmed the efficacy of pulmonary rehabilitation programmes<sup>7</sup>.

## MATERIALS AND METHODS

This study was conducted after taking approval from Institute Ethics committee and was conducted in the department of Physiology, Maulana Azad Medical College and the department of Medicine, Lok Nayak Hospital, New Delhi. Thirty patients of Chronic Obstructive Lung Disease of age 35 years and above undergoing treatment at the Chest Clinic and Medicine outpatient department of the Lok Nayak Hospital were included in the study. Informed consent was taken from all the patients. Particulars of the patients such as name, age, sex, number of packs per years of smoking etc were noted in a pre-structured proforma.

### Inclusion Criteria

1. Patients of COPD with age 35 years and above.
2. Patients able to do test of spirometry.
3. Patients giving their free and informed consent.
4. Patients with FEV1 <80% (or evidence of airway obstruction on pulmonary function testing) at room air PaO<sub>2</sub> > 55 mmHg.

### Exclusion Criteria

1. Patients of COPD with acute exacerbation (or having evidence of respiratory tract infection).
2. Patient suffering from any chronic illness like, hypertension, chronic liver disease, chronic renal failure, tuberculosis, lung cancer or any other malignancy, GI inflammatory disorder, prostatism, ischaemic heart disease or cardiac failure, diabetes mellitus or any endocrinologic diseases.

All 30 patients were advised and taught respiratory exercises in the form of diaphragmatic breathing, controlled coughing, pursed lip breathing light hand stretching and daily walking. The patients were told and motivated to follow the exercise regimen diligently at each weekly- visit during the six week study and to carry out at home also. Medications of the patients remained the same. Bronchodilators and other drugs were made available in case the patients required them during the rehabilitation training. Use of systemic steroids was not allowed during this period.

The following parameters of interest were measured at the time of enrolment into the study:

- Bicycle Ergometer- Endurance Time.
- 6-Minute Walk Test duration.
- Hand Grip Test and Endurance time.

All of the above mentioned parameters were repeated after 6 weeks of pulmonary rehabilitation.

### Education session

There was a single education session of 1 hour duration that covered topics such, as pulmonary pathophysiology, pharmacology of medications and breathing training (diaphragmatic breathing, controlled coughing, pursed lip breathing light arm stretching and daily walking, expiratory muscle augmentation and synchronization of thoracic and abdominal movement) (8,9).

**Six minute walk test** was used to assess the exercise capacity of the patient. These patients were asked to walk at their own pace while breathing room air for a duration of 6 minute on level ground. The patient could rest whenever he wanted, according to his need and exercise capacity, during the test. The distance covered was then measured in meters and noted down.

The patient was given constant encouragement and support during this time. This 6- minute walk test was done at the beginning and at the end of the pulmonary rehabilitation programme (6 weeks). Testing was performed under the supervision of nursing staff and resident doctor in a location where a rapid, appropriate response to an emergency was possible.

**Hand grip test** was carried out in a controlled setting on the non-dominant hand using the hand grip meter developed by INCO, Ambala. The test was carried out at room temperature, with the patient sitting on a chair, with the non dominant arm flexed at the elbow and the forearm resting on the arm rest of the chair. Three maximal measurements were made using the dynamometer held in the hand with the arm unsupported(10). The maximal result of each trial to the nearest kilogram was noted. Similar body position was used while testing all patients.

**Sub maximal cycle ergo meter test-** sub maximal exercise testing was performed on a cycle ergometer. Patients exercised at 50% of the maximum cycled load for 15 minutes. When the patient completed this exercise the work load was increased to 70% if required. The maximal endurance time was noted.

## RESULTS

Data collected from the study group was analyzed with statistical software package, SPSS using the student paired t-test. Descriptive statistics were carried out for the study group before and after pulmonary rehabilitation. Exercise capacity was measured by the 6-minute walk test (6-MWT), hand grip test(HGT) and the Bicycle Ergometry Endurance time (ET). These parameters are shown in the table no. 1.

**Table 1:** Descriptive statistics for the parameters of Exercise capacity before and after pulmonary rehabilitation. (N=30)

	Mean $\pm$ Std. Deviation	Minimum	Maximum	p-value
6-MWT Before(mts)	238.00 $\pm$ 70.04	120.00	325.00	p<0.001
6-MWT After(mts)	257.97 $\pm$ 70.00	130.00	350.00	
HGT (kgs) Before	14.64 $\pm$ 4.13	10.40	22.40	p<0.001
HGT (kgs) After	15.25 $\pm$ 4.05	10.00	22.60	
Endurance time (ET) (min) Before	467.00 $\pm$ 144.77	240.00	810.00	p<0.001
Endurance time (ET) (min) After	474.00 $\pm$ 146.02	245.00	812.00	

Student paired t-test showed that there were significant improvements in terms of exercise and its related parameters like 6-MWT (p-value< 0.001), HGT (p-value< 0.001), ET (p-value< 0.001)after pulmonary rehabilitation.

## DISCUSSION

COPD patients experience a progressive deterioration and disability leading to worsening of their health related quality of life. There have been ample studies directed towards examining the efficacy of various exercise capacity measuring parameters used in COPD<sup>11</sup>. As the exercise tolerance is a common problem in COPD patients, exercise training is considered an important component of the treatment. Various randomized controlled studies reported significant improvements in maximal exercise capacity, walking distance and endurance capacity after pulmonary rehabilitation.<sup>12-16</sup>

Higher mortality rate was observed in patients with the severe muscle weakness due to steroid-induced myopathy<sup>17</sup>. In a study by Toshima *et al*<sup>18</sup> and Ries *et al*<sup>12</sup> showed that a rehabilitation programme including exercise training resulted in significantly larger improvements in exercise capacity, symptoms and quality of life and decrease in mortality than an educational session alone. Studies showed significantly larger improvements in maximal and submaximal exercise responses were obtained after pulmonary rehabilitation at high exercise levels (70% maximal work load) in COPD patients<sup>13</sup>. Patients showed significant reduction in ventilation and lactate levels at identical submaximal workloads strongly suggesting improved aerobic metabolism. Reduced ventilation may be responsible for reduced dyspnoea at identical workloads after rehabilitation<sup>16</sup>. Lake *et al*<sup>19</sup> observed significant improvement in 6Minute Walk Distance (6MWD) after lower extremity training, but not after upper extremity training. Niederman *et al*<sup>20</sup> have reported that cycle ergometer training at half the maximal work rate 3 times a week for 8 weeks significantly improves the 6-minute walking distance. We trained our patients 2 times a week for 6 weeks at almost the same intensity as in this above study, which may explain the improvement in the 6-minute walking distance. Such specific training effects were also observed by others<sup>12, 13</sup>. Transfer effects to other activities have been shown, with cycle ergometer training improving walking<sup>21,22</sup> and vice versa<sup>15</sup>. Most training programmes involve training of lower extremity with cycling or walking or both. Study by Casaburi *et al*<sup>13</sup>

showed that training on cycle ergometer at 70%-80% of the maximal workload improved submaximal endurance time significantly more than training at 30% of maximal workload. COPD patients reported limitations for activities of daily living involving the upper extremity. In this study there was significant improvement in the score of hand grip test (p-value < 0.001). The measurements for the hand grip test improved from a mean value of 14.64  $\pm$ 4.13 kg to 15.25  $\pm$  4.05 kg after 6 weeks of intervention phase. Moreover many studies<sup>23, 24</sup> done in the past showed a significant improvement in the hand grip test in the patients treated with anabolic steroid as compare to this latter can also be recommended for the rehabilitation of COPD patients. Ries *et al*<sup>25</sup> and Lake *et al*<sup>19</sup> observed significant improvements in arm ergometer performance after upper extremity training. Respiratory Muscle function and especially inspiratory muscle function is compromised in COPD and this contributes to the dyspnoea<sup>26</sup>, exercise limitations<sup>27</sup> and hypercapnia<sup>28</sup>. Respiratory muscle training improves inspiratory muscle function on the condition that training intensity is fixed or monitored and exceeds 30% maximal inspiratory pressure<sup>29,30</sup> inspiratory muscle training in addition to exercise training has been shown to result in greater improvements in exercise capacity in patients with ventilatory limitations to exercise<sup>30</sup>.

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