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# EFFICACY OF UPPER EXTREMITY EXERCISE TRAINING ON PULMONARY FUNCTIONS IN PEOPLE WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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## ABSTRACT

**Background & Objective:** Upper extremities play an important role in many activity of daily living such as bathing, dressing and gardening. Patients with COPD frequently experience marked dyspnea and fatigue when performing these simple tasks. So, this is to find out the study effect ofupper extremity exercise training on pulmonary function in chronic obstructive pulmonary disease patient. Methods: An experimental design involving pre and posttest parameters between two groups treated with Upper extremity exercise training protocol and other group with conventional management. Outcome measurement such as pulmonary function- FVC, FEV1, FEV1/FVC and MVV were assessed pre intervention and post intervention after six weeks. Statically Analysis: Chi-square ($x^2$) test has been used to analyze the significant of basic characteristic ofthe subjects studied. Paired 't' test as a parametric and Wilcoxon signed rank test as a non-parametric test have been used to analysis the means of the subjects studied Independent 't' test as a parametric and Mann Whitney U test as a non-parametrictest have been used to compare the means of the subjects between the groups with calculation of percentage of difference between the means. Results: There is a statistically significant improvement in pulmonary functionswithin the Groups and there is no statistically significant difference inimprovement in means of FEV1/FVC and MVV between Groups. Conclusion: The present study concluded that Upper limb exercise training protocol have effect on improving pulmonary functions such as FEV1, FVC, FEV1/FVC and MVV in subject with COPD.

**Keywords:** Upper limb exercise training, Chronic obstructive pulmonary disease, Forced vital capacity, Forced expiratory volume in one second, Maximum voluntary ventilation, pulmonary functions.

## I. INTRODUCTION:

COPD is the only common chronic illness for which mortality rates continue to increase. The prevalence rate of COPD in Indian males is 5%and in females is 2.7%, male to female ratio being 1.6:1. The number of women with COPD is on the rise because of increased number of women smoking cigarettes and a part of passive smoking also. Chronic obstructive pulmonary disease (COPD) is a disorder characterized by the presence of airflow obstruction that is generally slowly progressive, may be accompanied by airway hyper reactivity, and may be partially reversible which limit physical activity.[1] The most commonly encountered risk factor for COPD is tobacco smoking and other are outdoor, occupational and indoor air pollution. COPD is one of the most common disabling conditions in young and elderly people. It is the 3rd most common cause of certified illness in India and fifth greatest cause of disability worldwide and it is the major cause of death increasing in prevalence.[2,3]

Chronic inflammation of the small airways and gradual destruction of the alveoli characterize COPD. Chronic inflammation results in fibrosis, which in turn leads to narrowing of the airways. These problems are aggravated by excessive mucus, which clogs the airways, resulting in spasm of the muscles that surround them. Terminal bronchioles collapse or are blocked by mucus plugs, and their alveoli die. Air becomes trapped in the distal airways, causing hyperinflation and alveolar dead space is increased. Hyperinflation in combination with narrowed airways and reduced gas exchange from loss of alveoli lead to breathlessness, exercise intolerance, and hypoxia.[4,5]

Proper lung function is determined by means of pulmonary function test. So, this study is going to determine the PFT changes of normal healthy individual with upper and lower extremity exercises training. Management of COPD includes pharmacological and non-pharmacological intervention. Pharmacological intervention include use of drugs such as bronchodilators, Long acting beta-agonist, glucocorticosteriods, antibiotics, antitussives, antiviral agents, Leukotriene Modifiers and mucolytics. While non-pharmacological intervention include Oxygen therapy and Pulmonary rehabilitation programme. The primary goal of pulmonary rehabilitation is to decrease symptoms, improve quality of life and increase participation in everyday activities.[6,7]

The effectiveness of pulmonary rehabilitation program has been well documented, with consistent and clinically significant improvement in exercise capacity, and health related quality of life. However, such programs primarily focus on exercise training. Upper extremities plays an important role in many activity of daily living such as bathing, dressing and gardening.[8]

Patients with COPD frequently experience marked dyspnea and fatigue when performing this simple tasks. Upper limb exercises generate 25% lower Vo2max than leg exercise, this difference relate to the relatively smaller muscle mass activated in upper body exercise. Also, unsupported arm exercises improve inspiratory muscle strength and endurance.[9]

## II. METHODOLOGY:

Study design: this study is an experimental design, all subjects were divided in to two groups one group received upper extremity exercise training and other received conventional management. There were total of 70 subjects COPD between age group of 30-45 years, 35 subjects in experimental group and 35 subjects in conventional group. Study setting: All the subjects were recruited from the inpatient and outpatient department of Saveetha Medical College and Hospital, Chennai. Dosage of the treatment is 1 session per day for 5 days a week, each day 30 minutes (4 sets of 10 repetitions). Inclusion criteria 1. Both males and females 2.Age group between 30 to 45 years 3.BMI between 18 to 25 kg/meter 4.Clinically diagnosed COPD patients with spirometer evidence of chronic air flow limitation. (Mild to moderate COPD i.e. FEV1/FVC < 70%). Exclusion criteria 1. cardiac diseases 2. restrictive lung diseases 3. neurological problems 4.Subjects with any musculoskeletal problems in Upper extremity 5.Subjects with cognitive disorder.

**Procedure:**

Informed consent was being taken from all the 70 subjects selected for the study on the basis of inclusion & exclusion criteria. The subjects was be divided into two groups i.e., experimental group & conventional group. Experimental group: 35 subjects received upper extremity exercise training. Conventional group: 35 subjects received conventional medical Management. Pre intervention measurement of PFT: Before commencement of training general assessment of subject was taken which include subject's height, weight, BMI, age, smoking history and PFT was taken. Pulmonary function test was taken pre and post training as per the standard outlined by American Thoracic Society. PFT was taken by using RMS spirometer 401 and window version 2000 / XP. Subject preparation: Before training the subjects were taken to the experimental room for PFT procedure. They were instructed to wear light and comfortable clothing while training. Position of subject: comfortable high sitting position on a table without back support and foot placement on floor and face should not focus on computer screen. Subject was instructed to place the nose clip in position. Then place mouthpiece and breath into the sensor as prescribed. Three trials were given and out of three best performances were taken into account. In each group subject was given 15 minutes of general warm-up including stretching and mild intensity of exercise followed by 35 minutes exercise training in coordination with respiration according to protocol and last 10 minutes of cooldown.

**EXERCISE PROTOCOL:** Experimental group (upper extremity exercise training): Immediately after 10 minutes of warm up the Subjects had received upper extremity exercise training for 35 minutes, one session per day (4 sets of 10repetitions), 5 days a week, for 6 weeks. Upper extremity exercises are following.

1. Overhead pulley exercise: Subject position: sitting on the table with foot supported on the floor. Procedure: subject was explained to perform alternate shoulder flexion and extension in co-ordination with respiration, while maintaining elbow in extension.

2. Push up: Subject position: hand and foot supported prone lying (push up position) Procedure: lower yourself to the ground during inspiration and explosively push up during expiration. Knee should be in extension throughout push up.

3. Shoulder abduction exercise: Subject position: standing position with elbow straight and relax Procedure: bilateral shoulder abduction with inspiration and adduction withexpiration performed.

4. Arm raise in quadruped position: Subject position: quadruped position. Procedure: perform alternate arm raise in quadruped position and take inspiration during arm raise and expiration while coming back to starting position. Shoulder flexion exercise: Subject position: standing position with elbow straight and relax Procedure: bilateral shoulder flexion with inspiration and extension withexpiration performed.

5. Shoulder retraction exercise: Subject position: Sitting position with elbow flexion and fingers clenched behindneck. Procedure: Bilateral shoulder retraction with inspiration and protraction withexpiration performed.

6. Shoulder rotation exercise: Subject position: Sitting position with elbow flexion and hands on shoulder. Procedure: Shoulder rotation in clock vise and anti- clock vise direction with inspiration and expiration.

**Outcome measures:** PFT (pulmonary function test):- PFT is valuable tools for evaluating the respiratory system. Spirometer provides important graphical and numerical data regarding the mechanical properties of the lungs, including FVC, FEV1, FEV1/FVC and MVV. Itcan be used to assess health status before enrolment in strenuous physical activity.[10] PFT was taken pre and post training with use of RMS 401 spirometer.

Spirometer is a device used to determine lung volumes and capacities. It comprise flash type sensor with a dismountable Circuit, pressure sensor, amplifier, voltage stabilizer and analogic to digital converter. Validity for the spirometers was found from the different study and inter tester reliability was tested.

Force vital capacity: Forced vital capacity (FVC) is the amount of air that can be maximally and forcibly expelled from the lungs after a maximal inhalation. FVC would be measured in volume of liters. The subjects were asked to take the deepest breath as much as they can and then they were instructed to place mouthpiece correctly in mouth and immediately carry out forceful expiration as hard as possible, for as long as possible, preferably at least 6 second. It is directly followed by a rapid inspiration. During the test, soft nose clip is used to prevent air escaping through nose. FVC, FEV1, FEV1/FVC were attained from above maneuver. Force expiratory volume in one second: Force expiratory volume in one second (FEV1) is the amount of air that is forcefully exhaled in first second of the FVC test. FEV1would be measured in volume of liters.The subjects were asked to take the deepest breath as much as they can and then they were instructed to place mouthpiece correctly in mouth and immediately carry out forceful expiration as hard as possible. FEV1/FVC ratio: This number is the ratio of FEV1 to FVC. It indicates what percentage of total FVC was expelled from the lung during the first second of forced exhalation. This number is called FEV1/FVC ratio, FEV1% or %FEV1. This value is critically important in the diagnosis of obstructive lung disease. This value would be obtained from FEV1 and FVC values. FEV1/FVC would be expressed as a % (percentage).Maximum voluntary ventilation (MVV): It is a measure of maximum amount of air that can be inhaled or exhale within one minute. For the comfort this is done over a 15 second time period. The subject was instructed to position mouthpiece correctly in mouth and do rapid and deep breathing for 1 minute. The total volume of air moved during test would be expressed in liter/minute.

## III. STATISTICAL METHODS:

Out Come measurements are measured using Pulmonary Function Test Measurements such as Forced Expiratory Volume in one second (FEV1) in liter; Force vital capacity(FVC) in liter, FEV1/FVC ratio in percentage, and Maximum voluntary ventilation (MVV) liter per minute, before and after intervention in the subjects studied. Descriptive statistics has been analyzed for the measurements and presented as mean SD. Significance is assessed at 5 % level of significance with p value 0.05 ( and p value is doubled for 2 tailed hypothesis) less than this is considered as statistically significant difference 95% Confidence interval of the difference was set during analysis. Descriptive statistical analysis has been carried out in the present study. Statistical tests: Chi-square ($x^2$) test has been used to analyze the significant of basic characteristic of gender, age and side distribution of the subjects studied. Paired 't' test as a parametric and Wilcoxon signed rank test as a non-parametric test have been used to analysis the means of Forced Expiratory Volume in one second (FEV1) in liter, Force vital capacity (FVC) in liter, FEV1/FVC ratio in percentage, and Maximum voluntary ventilation (MVV) liter per minute from pre-intervention to post-intervention with calculation of percentage of change. Independent 't' test as a parametric and Mann Whitney U test as a non-parametric test have been used to compare the means of Forced Expiratory Volume in one second (FEV1) in liter, Force vital capacity (FVC) in liter, FEV1/FVC ratio in percentage,and Maximum voluntary ventilation (MVV) liter per minute between the groups with calculation of percentage of difference between the means. Statistical software: The Statistical software namely Sigma plot was used to analyses the data's.

**Results:** In this study, the parameter such as Age, gender, BMI, FEV1, FVC, FEV1/FVC and MVV were measured and the analyzed to find the effect of upper limb exercise training in COPD patients. The study was carried out on total of 35 subject in each group Experimental group ; consisting 15 females and 20 male subjects in Conventional group; 16 females and 19 male subjects with no statistically significant difference in subjects takenwith p=0.197. Age Distribution of the subjects shows that in Experimental group there were 9 subjects in age group between 31-35 years and in 12 subjects in age group 36-40 and in 14 subjects in 41-45 years withmean age of the subjects studied was 41.40 years. In Conventional group there were 94 subjects inage group between 31-35, 13 in age group between 36-40, 13 subjects in age group 41-45years with mean age ofthe subjects studied was 41.93 years.

Analysis of BMI between the groups shows that there is no statistical significant difference in means of BMI between Groups.

Table 1: Analysis of FEV1, FVC, FEV1/FVC and MVV within the Experimental group

(Pre to post analysis)

| Experimental Group | Pre Intervention (Mean±SD in degrees) min-max | Post intervention (Mean±SDin degrees)min-max | t value | Significance(2-tailed) P value |
|---|---|---|---|---|
| FEV1 in l | 2.95 ± 0.17 (2.78 -3.40) | 2.97 ± 0 .17 (2.79 3.45) | -23.348 | P <0.0001 |
| FVC in l | 1.85 ± 0.14 (1.62 -2.24) | 1.90 ± 0 .14 (1.70 - 2.25) | -21.820 | P <0.0001 |
| FEV1/FVC % | 65.99 ± 2.78 (57- 63) | 67.60 ± 2.07 (58 - 71) | -9.951 | P <0.0001 |
| MVV l/m | 69.61 ± 3.46 (30 – 71) | 65.16 ± 4.10(59 - 71) | -20.012 | P <0.0001 |

The above table shows that there is a statistically significant difference in means of Forced Expiratory Volume in one second (FEV1), Force vital capacity (FVC), FEV1/FVC ratio in percentage, and Maximum voluntary ventilation (MVV) liter per minute, when means are compared from pre intervention to post intervention in Experimental group with p<0.0001.

Table 2: Analysis of FEV1, FVC, FEV1/FVC and MVV within the Conventional group

(Pre to post analysis)

| Conventional Group | Pre Intervention (Mean±SD in degrees) min-max | Post intervention (Mean±SDin degrees)min-max | t value | Significance (2-tailed) P value |
|---|---|---|---|---|
| FEV1 in l | 2.61± 2.66 (2.57 - 2.99) | 2.88± 0.13 (2.63- 3.07) | -11.324 | P <0.0001 |
| FVC in l | 1.66± 0.21 (1.38 -2.10) | 1.83± 0.11 (1.67-2.8) | -11.687 | P <0.0001 |
| FEV1/FVC | 67.23± 2.72 (59- 68) | 66.84± 2.26 (59 -68) | -7.348 | P <0.0001 |
| MVV | 59.32± 3.39 (51- 01) | 61.98± 4.71 (49 - 66) | -11.865 | P <0.0001 |

The above table shows that there is a statistically significant difference in means of Forced Expiratory Volume in one second (FEV1), Force vital capacity (FVC), FEV1/FVC ratio in percentage, and Maximum voluntary ventilation (MVV) liter per minute, when means are compared from pre intervention to post intervention in conventional group with p<0.0001.

## IV. DISCUSSION:

Major findings of this study found that FEV1, FVC, FEV1/FVC and MVV from pre to post training within the Groups showed that there is a statistically significant improvement in pulmonary functions. According to Pauwels in 2001 increasing prevalence of COPD with advancing age. This could be because of either cumulative exposure to smoking and other risk factors or loss of elasticity of lung tissue or both. And according to Wasserman andTaylor, in 2005 young female have smaller static and dynamic compliance than male even after accounting for difference in stature, this disparity produce expiratory flow limitation and greater use of ventilator reserve during maximal exercise. Also physical inactivity is more prevalent in female than of male with several studies showing thatboys are significantly more active than girls of the same age. So in this study age and sex were taken as an independent variable.[10-13] The BMI distribution of the subjects shows that statistically no significantdifference in mean BMI of subjects between the Groups. In 2010 Ling yung and others studied BMI and COPD related mortality and found that Low BMI is associated with increased mortality in a relatively lean adult male population in china. Hence in this study potentials factor related to COPD prevalence include age, sex, BMI, smoking and race/ethnicity were taken as an independent variables. Analysis of pulmonary functions within Group found that there was a statistically significant improvement in FEV1, FVC, FEV1/FVC and MVV in people with COPDat the end of 6 weeks.[14-16]

After upper limb exercise training this improvement in pulmonary functions could be because of the training induced increases in aerobic enzymes levels and oxidative capacity of the respiratory musculature contributes to enhance ventilator muscle function and improvement in respiratory muscle endurance.[17] This training increase inspiratory muscle capacity to generate force and inspiratory pressure and also reduce lactate production by ventilator muscle function. According to Rasmussen B et. al. pulmonary ventilation during endurance exercise gradually increases tidal volume, vital capacity and decrease breathing frequency. So, consistently air remains in lungs for longer time between breaths. This increases oxygen extraction from inspired air and decrease oxygen concentration in expired air.[18] According to Harrison A, Ferrara G combination of exercise training with inspiratory muscle has been more effective to improve exercise capacity than exercisetraining alone. Nici L, Donner C and Porta R and Couser JI found that upper extremity training resulted in increase pulmonary function. This might be due to improved synchronization and co-ordination of accessory muscle action.[19-22]

Comparison of pulmonary functions between the groups in post intervention showed that there was a statistically significant difference in means of FVC, FEV1 and MVV while there was no statistically significant difference in FEV1/FVC ratio. So, exercise training is beneficial to improve pulmonary function.

Ries AL et al (1998) studied the effect of upper extremity exercise training on minuteventilation and dyspnea in COPD and concluded that arm elevation and arm exercise require a higher of minute ventilation and produce more dyspnea than leg exercise for a given energy expenditure. Several form of upper extremity training have been devised, including repetitive arm motion, arm cycling. Many activity of daily living require proficiency at arm exercise is good training for patient who unable to tolerateleg-exercise.[23] Martinez Fet al (1997) studied the metabolic and respiratory consequences of simple arm elevation to 90 degree angle at shoulder level in patient with COPD and during arm elevation exercise minute ventilation and Vo2 max was measure in COPD patientthat showed a significant increase in Vo2 max and minute ventilation during arm elevation exercise in COPD.[24]

Bases on the finding in this study the improvement obtained by upper limb exercise training and conventional management measuring by pulmonary function FEV1, FVC, FEV1/FVC and MVV found there is statistically significant difference in effectiveness of upper limb exercise training. The improvement obtained in pulmonary functions found no difference between the groups. This signifies there is similar effect obtained in pulmonary functions between the groups. Therefore the present study accept null hypothesis.[25-27] Our group has conducted research relevant to physiotherapeutic intervention on various neurological and musculoskeletal ailments[28-33], and warrants further experimental research by our group in signifying the results.

## V. CONCLUSION:

The present study concludes that Upper extremity exercise training resulted in significant improvement in pulmonary function test (FEV1, FVC, FEV1/FVC and MVV) in COPD patients. Use of both method of treatment can be be recommended for clinical application inrehabilitation of COPD patients if the treatment aiming to improve pulmonaryfunction in early stage of pulmonary rehabilitation.

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