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Effect of resistance training combined with muscle stretching on the functional capacity and fatigue in patients with Copd

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is associated with reduced exercise capacity, muscle weakness, and increased fatigue. Rehabilitation strategies including resistance training and muscle stretching may improve functional outcomes.

Objective: To evaluate the effect of resistance training combined with muscle stretching on functional capacity and fatigue in patients with COPD.

Methodology: An experimental interventional study was conducted on 30 COPD patients divided into two groups. Group A received resistance training with upper and lower limb stretching, while Group B received resistance training combined with respiratory muscle stretching. Outcome measures included Borg Scale (RPE), 6-Minute Walk Distance (6MWD), and FACIT Fatigue Scale.

Results: Both groups showed significant improvement in functional capacity and fatigue ($p<0.0001$). However, Group B demonstrated greater improvement in 6MWD and fatigue scores compared to Group A.

Conclusion: Resistance training combined with respiratory muscle stretching is more effective in improving functional capacity and reducing fatigue in COPD patients.

Keywords: COPD, Resistance Training, Muscle Stretching, Fatigue, 6MWD, Physiotherapy

Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic inflammatory lung disease that causes obstructed airflow from the lungs. Symptoms include breathing difficulty, cough, mucus (sputum) production and wheezing. It's caused by long-term exposure to irritating gases or particulate matter, most often from cigarette smoke. The patient do not visit the physician until the condition is quite advance often only after an acute exacerbation.

Emphysema and chronic bronchitis are the two most common conditions that contribute to COPD. Chronic bronchitis is inflammation of the lining of the bronchial tubes, which carry air to and from the air sacs (alveoli) of the lungs. It's characterized by daily cough and mucus (sputum) production.

Emphysema is a condition in which the alveoli at the end of the smallest air passages (bronchioles) of the lungs are destroyed as a result of damaging exposure to cigarette smoke and other irritating gases and particulate matter.

"Pink puffer" – emphysema patients may have higher PO2 readings. Respiratory effort can be described as shallow, puffing, tachypnea, respirations through pursed lips. These patients have an increased metabolic rate.

"Blue bloater" – chronic bronchitis patients may appear swollen and cyanotic due to the hypoxemia and edema. These patients often have decreased right heart function that causes the edema.

COPD is characterized by a progressive and persistent airflow limitation and decreased parenchymal elasticity. Consequently, the respiratory muscles remain contracted for prolonged periods in an attempt to meet the increased ventilatory flow demand, increasing the load on the respiratory muscles. The association between both conditions (hyperinflation and increased respiratory demand) reduces the contractile range of the sarcomere of the respiratory muscles, triggering mechanoreceptors to stimulate the respiratory centers and further increase ventilation, resulting in even more severe dyspnea. This vicious cycle continues because the increase in dyspnea further stimulates increases in the ventilatory demand. Dyspnea and the shortening of respiratory muscles hamper the performance of activities that require more effort, which results in physical deconditioning in patients with COPD [2].

The skeletal muscle dysfunction has become more common in the paitents with chronic obstructive pulmonary disease (COPD). Endurance and the muscle strength are decreased, and the muscle fatigability is increased in Chronic obstructive pulmonary disease. In chronic obstructive pulmonary disease the proportion of type 1 fibers are reduced whereas type 2fibers are increased. Reduction in the fiber cross-sectional are occurs due to muscle atrophy. Reduced in the measurement of bioenergetics during daily life activities, Oxidative enzyme activity is also decreased [6].

The muscle stretching modifies the properties of tissues, increasing sarcomere size and muscle viscoelasticity. There is also evidence that respiratory muscle stretching increases the capacity for chest wall (CW) expansion, suggesting an improvement in ventilation in patients with COPD [2].

Rate of perceived exertion (RPE) is a widely used and reliable indicator to monitor and guide exercise intensity. The scale allows individuals to subjectively rate their level of exertion during exercise or exercise testing. The original Borg scale or category scale (6 to 20 scale) are used in clinical practice to measure perceived exertion; The Modified Borg Dyspnea Scale is most commonly used to assess symptoms of breathlessness.

The 6-min walk (6MW) distance is commonly used to assess exercise capacity in patients with COPD and to track functional change resulting from disease progression or therapeutic intervention.

Many COPD patients experience muscle dysfunction and reduced muscle mass, primarily as a result of chronic immobilization. These symptoms have been associated with reduced exercise tolerance and complaints of fatigue and dyspnea (even after minimal exertion). People with chronic obstructive pulmonary disease have reduced airflow into the lungs making breathing difficult. It also reduces the oxygen supply to whole body, because of compromised oxygen supply, body gets tired and exhausted. COPD is progressive so symptoms of disease grow worse over time. Without proper exchange of gases body don't get oxygen enough. This develops low blood oxygen levels, condition called as hypoxemia. When the body muscles don't get enough oxygen the muscle goes in fatigue [3].

The FACIT Fatigue Scale is one of many different FACIT scales that are part of a collection of health-related quality of life (HRQOL) questionnaires targeted to the management of chronic illness referred to as The FACIT Measurement System.

The peripheral muscle strength is significantly reduced in chronic obstructive pulmonary disease (COPD) patients compared with normal subjects, and that this muscle weakness to a great extent is responsible for the reduced working capacity observed in these patients. [1] This reduced peripheral muscle strength has partly been explained by a pronounced loss of muscle mass in COPD patients. Furthermore, the inactive lifestyle and the reduced physical function are related to the reduced quality of life and greater prevalence of depression reported by COPD patients. skeletal muscle dysfunction and reduced muscular strength have become a recognized sources of disability in chronic obstructive pulmonary disease.

The factors such as peripheral muscles weakness, deconditioning and impaired gas exchange are now recognized as important contributors to reduced exercise tolerance

The consequence of exercise intolerance appear important to COPD patients. Poor exercise capacity has also been shown to contribute to mortality. Lower-extremity exercise training consistently improve exercise tolerance in patients with chronic obstructive pulmonary disease. Resistance training can promote muscle growth and strengthening in patients.

Muscle growth and strengthening can be promoted by strengthening exercise in patient with chronic obstructive pulmonary disease. To improve peripheral muscle function, this training can enhance exercise tolerance in patient with chronic obstructive pulmonary disease. [4]

In chronic obstructive pulmonary disease (COPD) resistance training is important. As many patients in chronic obstructive pulmonary disease patient experience muscle dysfunction, muscle mass is reduced. all of this symptoms have been associated with reduce in the exercise tolerance and complaint of fatigue and dyspnea even after the minimal exertion [5].

Hence it is important to study on skeletal muscle dysfunction, muscle mass reduction, and muscle fatigue in patients with chronic obstructive pulmonary disease.

Need of study

Patients with COPD present a major recruitment of the inspiratory muscles increasing the degree of dyspnea and impairing their exercise capacity. Stretching technique could decrease the respiratory muscle activity and improve their contractile capacity. Strength training can promote muscle growth [2].

A greater strength of large group of muscle after training may reduce the perception of muscle fatigue, a common limiting symptom during exercise in patients with COPD [4].

There is very little evidence to support the recommendation of respiratory muscle stretching in clinical practice for treating patients with COPD.

Hence the need to study the effectiveness of resistance training combined with respiratory muscle stretching on the functional capacity and fatigue in patients with COPD

Aim and objective

Aim

To find the effect of resistance training combined with muscle stretching on the functional capacity and fatigue in patients with COPD.

Objectives

To find out the effect of resistance training combined with muscle stretching on the functional capacity by using Borg scale (RPE) and 6 min walk distance.

To find out the effect of resistance training combined with muscle stretching on the fatigue using functional assessment of chronic illness therapy scale.

To find out the effect of resistance training combined with upper and lower extremity muscle stretching on the functional capacity by using Borg scale (RPE) and 6 min walk distance.

To find out the effect of resistance training combined with upper and lower extremity muscle stretching on the fatigue using functional assessment of chronic illness therapy scale.

To compare the effect of resistance training and upper and lower extremity stretching with resistance training and respiratory muscle stretching in patients with COPD.

Hypothesis

Null Hypothesis

There is no effect of resistance training combined with respiratory muscle stretching on the functional exercise capacity and fatigue in patients with COPD.

Alternate hypothesis

There will be effect of resistance training combined with respiratory muscle stretching on the functional capacity and fatigue in patients with COPD.

There will be effect of resistance training with upper and lower extremity stretching and resistance training with respiratory muscle training on the functional capacity and fatigue in patient with COPD.

Review of literature

- **Juliano T Wada, Erickson Borges Santos (2016)**

Underwent a study on Effects of aerobic training combined with respiratory muscle stretching on the functional exercise capacity and thoracoabdominal kinematics in patients with COPD: a randomized and controlled trial. Concluded that aerobic training combined with respiratory muscle stretching increases the functional exercise capacity with decreased dyspnea in patients with COPD. These effects are associated with an increased efficacy of the respiratory muscles

- Sarah Benard, Francois Wittom (1998) -Aerobic and Strength Training in Patients with Chronic Obstructive Pulmonary Disease: cocluded that

- **Elaine Paulin; Antonio Fernando Brunetto (2003)**

Effects of a physical exercises program designed to increase thoracic mobility in patients with chronic obstructive pulmonary disease: concluded that exercises aimed to the increasing of chest wall mobility improve thoracic mobility, quality of life, submaximal exercise capacity, and reduce dyspnea and depression symptoms in chronic obstructive pulmonary disease patients.

- **Strasser B, Siebert U, Schobersberger W. (2004)**

Effects of resistance training on respiratory function in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis.: concluded that on findings from the meta-analysis, resistance training produces a clinically and statistically significant effect on respiratory function (such as forced vital capacity) and is therefore recommended in the management of COPD.

Rodrigo C. BorgesMSc

Impact of Resistance Training in Chronic Obstructive Pulmonary Disease Patients During Periods of Acute Exacerbation: concluded that resistance training during hospitalization improves the 6MWD, HRQOL, and lower-limb muscle strength, without altering the levels of systemic inflammation.

Material and Methodology

- Study design - Experimental
- Study type - Interventional
- Sample method - Convenient
- Sample size - 30
- Target population - People suffering from COPD
- Study duration - 6 months
- Study setup - Hospitals in and around Pune
- Material required - Sphygmomanometer, measuring tape, elastic band.
- Inclusion criteria –
- People suffering from COPD
- Age group between 30-50 year old
- Both male and female.
- Exclusion criteria –
- Patients diagnosed with other severe cardiorespiratory conditions.
- Those who are not willing to participate.
- Outcomes measures -
- Borg scale for dyspnea
- 6 min walk distance for function exercise capacity
- Fatigue scale Functional assessment of chronic illness therapy (FACIT) scale
- Procedure
- The permission was taken from the concerned ethical committee.
- The samples were selected according to the inclusion and exclusion criteria.
- The aim and method of the study was explained to them
- The samples was assessed for symptoms severity with American thoracic society.
- The samples was assessed for dyspnea by using Borgs scale and functional exercise capacity will be checked by doing 6 min walk test.
- Two groups will be formed (group A, group B)
- Group A was given resistance training with upper and lower limb stretching and Group B was given respiratory muscle stretching and resistance training.

Respiratory muscle stretching: The program was based on hold–relax and passive stretching techniques and involved the scalene, sternocleidomastoid, trapezius, pectoralis major and minor, intercostal, serratus anterior, and rectus abdominis muscles. The hold–relax stretching technique involves performing a passive stretch up to the maximum range of motion interspersed with 3 seconds of isometric contraction with three repetitions, which is called a “cycle”. Three sets of three cycles were interspersed with 1 minute of rest. Passive stretching was sustained for 1 minute, with 1 minute of rest between stretches and repeated three times, and held for the muscles (pectoralis minor, intercostal, anterior serratus, and ABDs).

Resistance training: Resistance training is given to increase peripheral muscular endurance biceps brachii, triceps brachii, serratus anterior, latissimus dorsi and quadriceps femoris by using elastic band that could improve functional capacity, muscular function and endurance cycle capacity. The intensity will be initially one repetition maximum will be used to set the load for the first week at 50%with 6-9 sec per repetition with 1 min rest between the sets. By the second week or as tolerated the load will be increased to 80%.

Muscles	Positioning	Start position	Final position
[a]Major pectoralis	Supine decubitus	90° shoulder abduction with external rotation, 90° elbow flexion, and sternal stabilization	Maximum horizontal extension of the shoulder
Minor pectoralis	Supine decubitus	Shoulder elevation with upper ribs stabilization	Maximum depression of third to fifth ribs
Upper trapezius	Supine decubitus	Neck contralateral rotation and lateral inclination with shoulder stabilization	Maximum neck flexion
Scalene	Supine decubitus	Neck lateral inclination with shoulder stabilization	Maximum neck lateral inclination
Sternocleidomastoid	Supine decubitus	Neck ipsilateral rotation and extension with manubrium stabilization	Maximum manubrium depression
Intercostals and anterior serratus1	Lateral decubitus	Maximum shoulder abduction with lower ribs stabilization	Maximum lower ribs depression

Result

Group 1 (Expremental Study)					
Fatigue scale (FACIT)	**Mean± SD**	**Std.Error**	**Median**	**Min**	**Max**
Pre	42.2	1.010	43.00	37.0	48.0
post	45.26	0.98	45.00	39.0	50.0

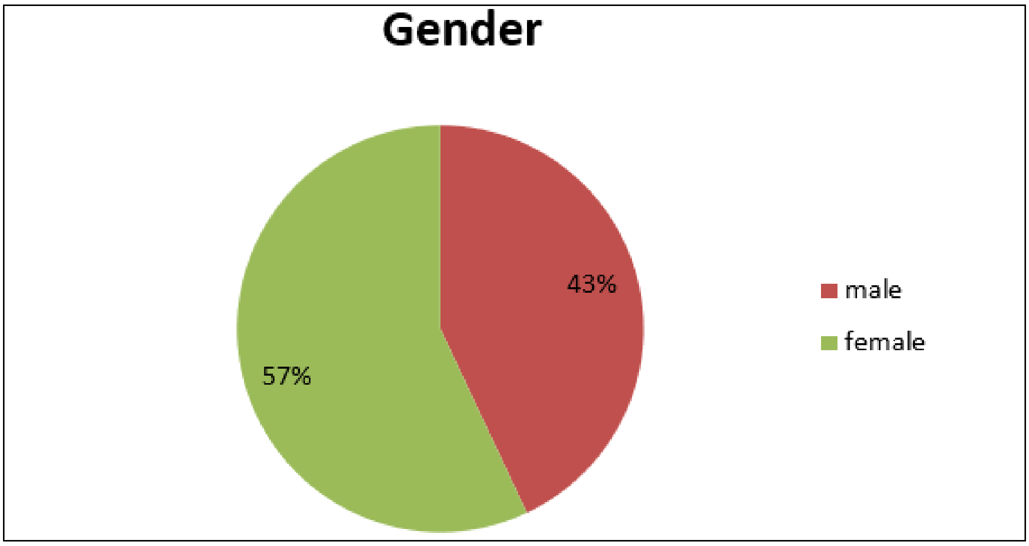
Group 1 (Expremental Study)					
6 min walk distance	**Mean± SD**	**Std.Error**	**Median**	**Min**	**Max**
pre	143.33	7.66	150.0	80.0	180
post	185.33	7.61	180.0	140.0	240.0

Group 2 (conventional Study)					
Fatigue scale (FACIT)	**Mean± SD**	**Std.Error**	**Median**	**Min**	**Max**
pre	42.73±3.515	0.9075	42.0	38.0	48.0
post	44.53±3.182	0.8215	43.0	40.0	49.0

Group 2 (Conventional Study)		Std.Error			
6 min walk distance	**Mean± SD**	**Std.Error**	**Median**	**Min**	**Max**
pre	142.66±25.48	6.58	140.0	100.0	170.0
post	166.66±26.36	6.808	170.0	120.0	210.0

Table 1: Demographic Data

gender	No.
male	13(43%)
female	17(57%)



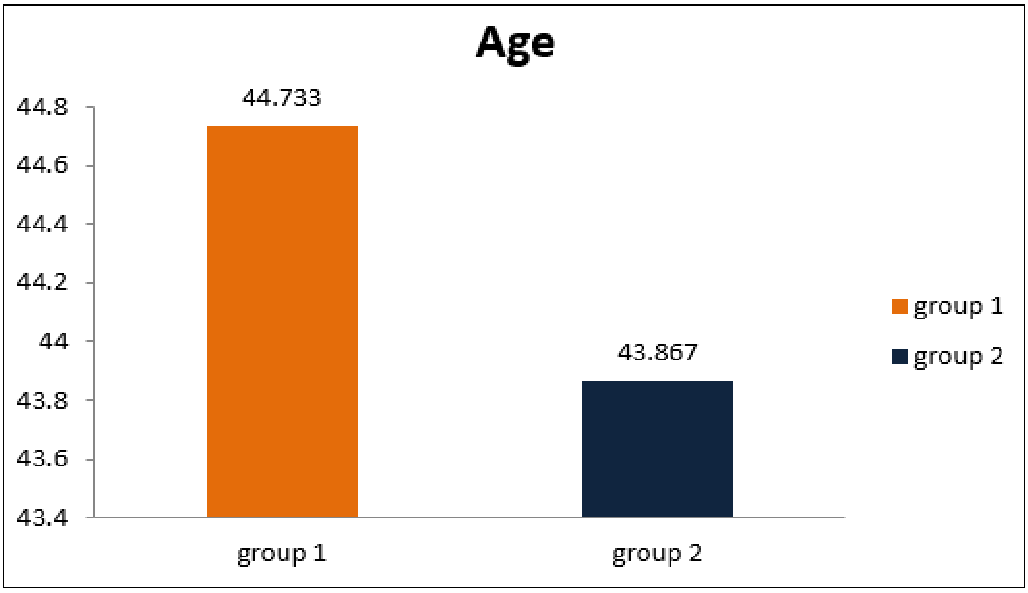
Interpretation

Table no:1 and graph no 1 shows gender distribution of subject included in the study, the total no of subject were 30 among which there were 13 males (43%) and 17 females (57%)

Table 2: Age distribution

Age	Mean ±SD
group 1	44.733±8.146
group 2	43.867±6.413

Graph 2

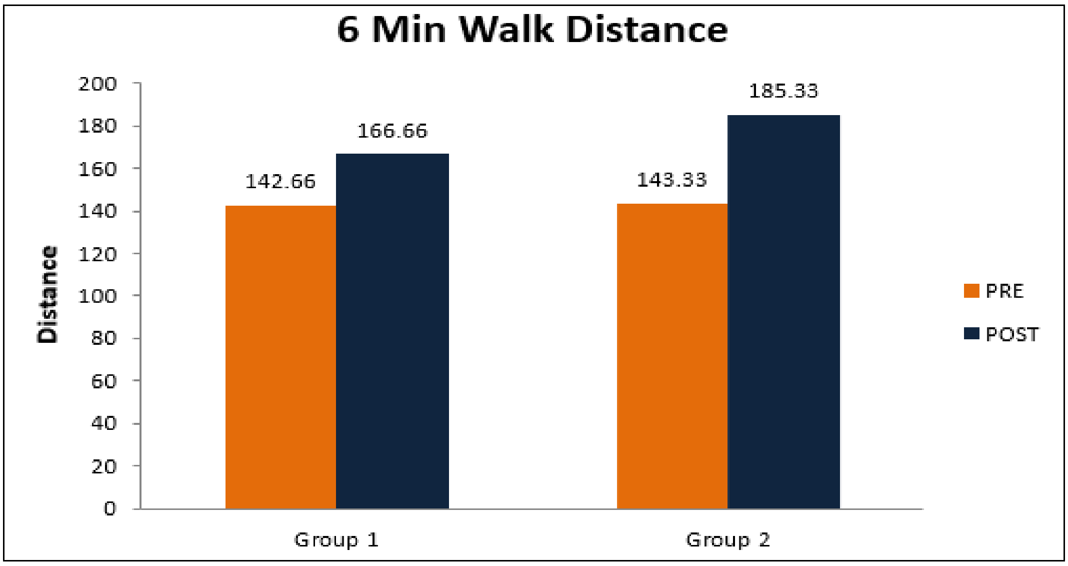


Interpretation
Table no:2 and graph no 2 shows Age distribution of subject included in the study, among 30 participants, 15 were in group 1 with mean age of 44.733±8.146 and 15 were in group 2 with mean age of 43.867±6.413.

Table 3: Comparison of 6 min walk test distance

6MWD	Group 1	Group 2
PRE	142.66±25.486	143.33±29.681
POST	166.66±26.367	185.33±29.488
P value	P<0.0001	p<0.0001

Graph No 3

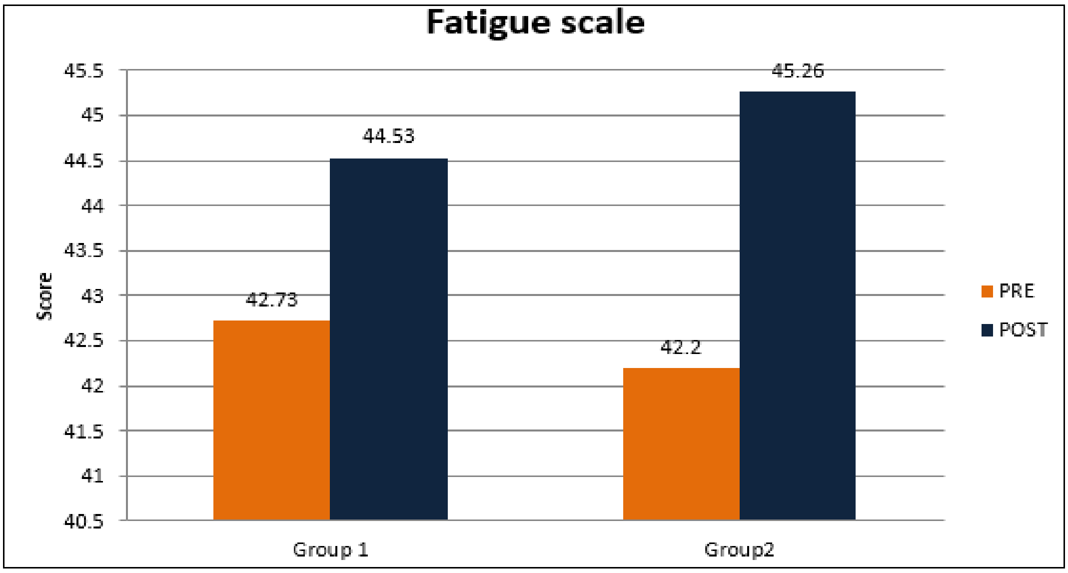


Interpretation
Graph no: 3 shows distribution of 6 min walk distance
The post treatment mean scores of 6 min walk distance (166.66±26.367) were extremely significant (p<0.0001) when compared to pre treatment scores (142.66±25.486) in Group 1.
The post treatment mean scores of 6 min walk distance (185.33±29.488) were extremely significant (p<0.0001) when compared to pre treatment scores (143.33±29.681) in Group 2.

Table 4: Distribution of functional assessment of chronic illness therapy (FACIT)

Fatigue	Group 1	Group2
PRE	42.73±3.515	42.2±3.913
POST	44.53±3.182	45.26±3.826

Graph no:4



Interpretation

Graph no:4 shows distribution of functional assessment of chronic illness therapy (FACIT)

The post treatment mean scores of fatigue scale (44.53±3.182) were extremely significant ($p<0.0016$) when compared to pre treatment scores (42.73±3.515) in Group 1.

The post treatment mean scores of fatigue scale (45.26±3.826) were extremely significant ($p<0.0001$) when compared to pre treatment scores (42.2±3.913) in Group 2.

Discussion

Chronic obstructive pulmonary disease is a preventable and treatable disease characterized by chronic airflow limitation that is not fully reversible. The airflow limitation does not change over several months and is usually progressive in the long term. It is associated with an abnormal inflammatory response of the lungs to the noxious stimuli, predominantly smoking. Other factor particularly occupational exposure, may also contribute to the development of chronic obstructive pulmonary disease. Exacerbation often occur, where there is rapid sustained worsening of symptoms beyond normal day to day variations.

Exposure to noxious particle, such as cigarette smoke and air pollution over a period can lead to lung inflammation with an associated increased number of neutrophils in the air way lumen and macrophages in the respiratory epithelium and parenchyma. After the years of exposure to the noxious particles the lumen becomes narrower. The function of the cilia is impaired and the elasticity of the smooth muscle is reduced, and fibrosis occurs. Physiological changes in chronic obstructive pulmonary disease are characterized by mucos hyper secretion, air flow limitation and air trapping. The mucus hypersecretion will lead to chronic productive cough, feature of chronic bronchitis. Many patient with chronic obstructive pulmonary disease suffer from exercise intolerance. Patient exercise capacity is limited by alteration in the skeletal muscle rather than pulmonary problem. Chronic obstructive pulmonary disease is often associated with muscle wasting and slow to fast shift in fiber type composition resulting in weakness and an earlier onset of muscle fatigue. limiting muscle wasting during chronic obstructive pulmonary disease being the patient by improving the quality of life.

Our study shows that there is more improvement in patients who were undergoing the experimental exercise along with the conventional training than those patients following conventional training program. Resistance training produce significant and relevant improvement in muscle strength and function performance indicating better daily living in chronic obstructive pulmonary disease. A study by M Kongsguard, N Beyer states that heavy resistance training increase muscle size, strength and physical function in elderly male COPD paitents [7].

In COPD Paitent inspiratory muscles are more affected. Due to this there is increase in the degree of dyspnea and imparing their exercise capacity. Respiratory muscle stretching technique could decrease the respiratory muscle activity and improve their contractile capacity. A study by Juliano T Wada, Erickson states that effect of aerobic training combined with respiratory muscle stretching on the functional exercise capacity and thoracoabdominal kinematics in patients with COPD: a randomized and controlled [2].

Lower extremities muscle weakness is frequently observed in patients with chronic obstructive pulmonary disease. Which contributed to exercise limitation, impaired health status. Muscle wasting of the extremities has been related to peripheral muscle dysfunction in COPD, this contributes in abnormalities in quadriceps muscle. Loss of muscle strength, muscle endurance or combination of these leads due to muscle weakness

In our study for group 1 we have given conventional exercise i.e. stretching of lower and upper limb combined with resistance training. Stretching and resistance training is given to improve muscle strength and muscle endurance. The Function Peripheral muscle group especially of upper limbs also get impaired in patient with Chronic obstructive pulmonary disease. A study by Frits M.E. Franssen, Paul P. Janssen states that limb muscle dysfunction in COPD: Effects of Muscle wasting and Exercise traning. [8]

A study by Micheal T Putt, Michelle Watson states that muscle stretching technique increases vital capacity and range of motion in patient with chronic obstructive pulmonary disease. which concluded that hold and relax technique produces shoet term benefits in patients with COPD [9].

Dyspnea is one of the most important and debilitating symptoms in paitent with Chronic obstructive pulmonary disease. Progressive dyspnea causes fatigue and reduces health-related quality of life.Due to dyspnea people with chronic obstructive pulmonary disease which reduce the use of arm activity of daily living such as cooking, or driving. Fatigue and dyspnea in patients with Chronic obstructive pulmonary disease is reduced by pulmonary rehabilitation which improve exercise capacity. This also improve quality of life for patients with Chronic obstructive pulmonary disease by improving functional capacity and reducing dyspnea. A study by lei Pan did study on Does upper extremity exercise improve dyspnea in patients with COPD. Which concluded that unsupported upper extremity exercise can improve dyspnea and arm fatigue during activity in daily life (ADL) in patient with chronic obstructive pulmonary disease and should be included in the pulmonary rehabilitation program [10].

In our study both of the groups were given resistance training to improve the functional capacity, endurance and strength of the muscle of lower extremity and upper extremity. Resistance training is recommended to increase peripheral muscular endurance in patients, however the design of resistance training is on the bases of exercise capacity and health related quality of life in patients with chronic obstructive pulmonary disease. in our study the design of resistance training was taken by analyzing the fatigue scale i.e. Functional assessment of chronic illness therapy (FACIT) scale and American thoracic society (ATS). A study by Andre Nyberg, Britta Lindstrom states that low – load / high – repetition elastic band resistance training in patients with COPD: a randomized controlled, multicenter trial. Concluded that Resistance training can increase functional capacity and muscular function in patient with moderate –to- severe Chronic obstructive pulmonary disease [11].

Muscle work increases in chronic obstructive pulmonary disease due to air flow limitation. respiratory muscle fibers show several degree of impairment in cellular and subcellular structure.The exitance of a “fragile balance” between respiratory muscle overload and respiratory muscle adaptation in chronicobstruvtive pulmonary disease. A study by MOrozcon- levi did study on upregulation of pro-inflammatory cytokines in the intercostal muscles of COPD patients [12].

Structural change and dynamic collapse in samall airway lead due to lung parenchyma which causes in chronic obstructive pulmonary disease.repercussions in chest wall, reduction of the apposition zone, change in the diaphragm muscle fiber,lung hyperinflation and air trapping causes due to expiratory airflow limitation in chronic obstructive pulmonary disease.Increase the work of breathing, increase resistance of the chest wall to expansion, inspiratory muscle fibers become shorter due to hyperinflation in chronic obstructive pulmonary disease.A study by Rafaela Barros de studied that immediate effect of respiratory muscle stretching on chest wall kinematics and electromyography in chronic obstructive pulmonary disease patients.Concluded that muscle stretching technique could be considered in the management of patient with chronic obstructive pulmonary disease [13].

The study finding are of clinical importance as various aspects like fatigue, American thoracic society grading have been evaluated in this group. This findings can help in better prognosis and rehabilitation of chronic obstructive pulmonary disease patients. It also helps in determining the rehabilitation protocol based on the interpretation obtained through individual scale.

Conclusion

Conclusion: the study concluded that Respiratory muscle stretching technique and resistance training is more effective than upper limb stretching lower limb stretching with resistance training which can be considered in the management of patient with chronic obstructive pulmonary disease.

Limitation

Small sample size

Severe patients were not included in study

Future scope of study

Future scope of study:

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