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EFFECT OF RESISITIVE RESPIRATORY MUSCLE TRAINING VERSUS THRESHOLD INSPIRATORY MUSCLE TRAINING ON RESPIRATORY MUSCLE STRENGTH AND QUALITY OF LIFE ON SUBJECTS WITH COPD

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Abstract: **Background and Objective:**Chronic obstructive pulmonary disease is a diverse lung disease defined by chronic respiratory symptoms (dyspnea, cough, expectoration and /or excerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, typically progressive, airflow obstruction In Physiotherapy treatment there are airway clearance techniques like resistive respiratory device and threshold inspiratory muscle training techniques have been proposed as an adjunct to conventional therapy to treat COPD. Both the techniques have been proved in increasing inspiratory muscle strength and quality of life in COPD and the literature is limited on their comparison Hence need of the study arises.

Methods: A quasi-experimental study design. 76 subject with FEV1/FVC<70% with clinical diagnosis of COPD were randomly allocated into two groups. In Group -A subjects (n=38) were treated with Resistive respiratory muscle trainer (breather) device and conventional physiotherapy training whereas in Group-B subjects (n=38) threshold inspiratory muscle training and conventional physiotherapy. The participants were given intervention thrice a week for 6 weeks. The Outcomes of this intervention was measured in terms of maximum inspiratory mouth pressure and st. George respiratory questionnaire.

Results: Independent 't' test was used to compare the mean significance difference between continuous variables Paired 't' test was used to assess the Statistical significance difference between pre and post test scores. Statistical analysis of data revealed that within the group comparison both groups showed significant improvement in all parameters. Where as in between group comparison breather Device technique showed better improvement compared to threshold inspiratory muscle trainer.

Conclusion: After 6 weeks of interventions both resistive respiratory muscle trainer and threshold inspiratory muscle trainer were shown statistically significant in improving inspiratory muscle strength and quality of life .However, resistive respiratory muscle trainer

showed greater improvement in pi-max and SGRQ. Hence, we conclude that breather is a convenient, easy to use and Safe, in impriving inspiratory muscle strength along with quality of life in subjects with COPD.

I. INTRODUCTION

Chronic obstructive pulmonary disease is a diverse lung disease defined by chronic respiratory symptoms (dyspnea, cough, expectoration and /or excerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, typically progressive, airflow obstruction[1]

COPD effects 4 to 6% of the population it is the major cause of morbidity throughout world and it is projected to be the 3-leading cause of death by 2020 . It represents an important public health challenge that is both preventable and treatable many people suffer from this disease for years and may die prematurely because of its complications .Globally the economic and health related burden of COPD is 11.37% found throughout the world. Prevalence rate of COPD varied in different reported studies with rate among ranging from 7.7% in india .

COPD is caused by gene-environment interactions that harm the lungs and disrupt normal development over time.Tobacco smoking, inhaling harmful particles and chemicals from household products, and outdoor air pollution are the primary environmental factors contributing to COPD [2].

COPD clinical signs include dyspnea, persistent cough (productive or nonproductive cough), limited exercise capacity, loud wheezing, and more frequent or longer bronchial infections,weight loss is another sign of severe COPD . The occurrence of at least one of these manifestations in the presence of a risk factor (typically cigarette smoking) should raise the possibility of COPD. Patients describe dyspnea as a feeling of not obtaining enough oxygen, an increase in effort during inspiration or expiration, or chest tightness. Dyspnea can occur during physical activity, while the patient is speaking, or at rest. [3]

COPD is marked by inflammation in the small airways and destruction of lung tissue, resulting in emphysema. The condition progressively worsens and is linked to an abnormal inflammatory response to inhaled harmful particles or gases. Neutrophil activation releases free radicals, cytokines, and proteases, which damage lung tissue, increase mucus production, and reduce elasticity. Airflow limitation causes chest hyperinflation and impaired lung recoil, leading to air trapping that restricts both exhalation and inhalation. These changes compromise diaphragm function, causing shortness of breath and limiting physical activity.[4]

The main diagnostic tool for COPD is spirometry, a pulmonary function test that evaluates lung capacity and airflow. Blood tests may be used to determine disease severity and exclude other conditions with similar symptoms. While smoking and exposure to harmful substances are the leading risk factors, genetic susceptibility also contributes to COPD. Chest X-rays can support diagnosis and assess symptoms such as chronic cough or breathlessness, showing features like enlarged lungs, bullae, and a flattened diaphragm. Computed tomography (CT) scans provide a more precise and early detection of emphysema and can reveal additional COPD-related changes, including enlarged pulmonary arteries, and are occasionally used for further assessment.[5]

The Breather is a non-drug respiratory device designed to enhance respiratory muscle training (RMT) by encouraging users to breathe through different aperture sizes, thereby strengthening the respiratory muscles. By applying resistance during both the inhalation and exhalation phases, The Breather helps improve both inspiratory and expiratory muscle strength. This process promotes the growth of respiratory muscle fibers, increases muscle thickness, and enhances the velocity of diaphragm movement.[6]

The Threshold Inspiratory Muscle Trainer (Philips Respironics) features a one-way, spring-loaded valve on one end and a mouthpiece on the other. To inhale effectively, users must generate sufficient inspiratory effort to overcome the pressure exerted by the spring-loaded valve. Until this pre-set pressure, measured in cmH_2O, is reached, airflow remains restricted. The device's resistance is determined by adjusting its pressure setting to 50% of the participant's maximum inspiratory pressure (MIP) measured during initial assessment. This resistance level will be modified as necessary throughout the training period.[7]

Conventional physiotherapy include balloon blowing exercises, chest physiotherapy, and incentive spirometry.The balloon blowing exercise is performed in an upright position with a balloon diameter of 7 inches.The subjects were asked to stretch the balloon. First, they took a deep breath and totally inflated the balloon. Pinch off the balloon, and no air should escape.[8]

Chest physiotherapy seeks to move secretions and allow effective expectoration, hence controlling cough and improving airway clearance. It is frequently recommended as a primary mode of treatment for this chronic condition. The chest physiotherapist trained each patient to do three sets of the following cycle during each treatment session: Ten breaths, followed by two or three forced expiratory methods (huffs) or coughs.[9]

The Incentive Spirometry is a flow-oriented incentive spirometer with three chambers (600, 900, and 1200 cc/s), each containing a ball and a mouthpiece. After a calm exhale, subjects were asked to take slow complete inspirations and hold them for as long as possible (at least 5 seconds) before gently exhaling. The balls were elevated and suspended by a prolonged inspiratory flow.[10]

II. AIM OF THE STUDY

The aim of the study is to compare the effects of resistive respiratory muscle training versus threshold inspiratory muscle training on respiratory muscle strength, and quality of life on subjects with COPD

III. NEED OF THE STUDY

Chronic obstructive pulmonary disease is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, expectoration and/or exacerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, often progressive, airflow obstruction. In COPD airflow limitation leads to hyperinflation of thorax which reduce elastic recoiling of the lung, expiratory airflow limitation leads to increase in end expiratory lung volume and decrease in inspiratory capacity this adaptations reduces diaphragm to contract during inspiration and thus limit inspiratory flow leading to dyspnea ,decreased inspiratory muscle strength ,and quality of life . Resistive respiratory muscle training helps by breathing through different sized apertures, thereby increasing respiratory muscle strength. As resistance is applied during both phases of the breath cycle, The Breather increases inspiratory as well as expiratory muscle strength by causing hypertrophy of the respiratory muscle fibers, and thickening and increased velocity of the diaphragm.

IV .OBJECTIVES OF THE STUDY

1. To determine the effects of resistive respiratory muscle training on respiratory muscle strength, and quality of life on subjects with COPD .

2.To determine the effects of threshold inspiratory muscle training on respiratory muscle strength, and quality of life on subjects with COPD.

3.To compare the effects of resistive muscle training versus threshold inspiratory muscle training on respiratory muscle strength and quality of life on subjects with COPD.

V .HYPOTHESIS

RESEARCH HYPOTHESIS(H_1):

Resistive respiratory muscle training may be more effective when compared to Threshold inspiratory muscle training on respiratory muscle strength, and quality of life on subjects with COPD.

NULL HYPOTHESIS (H_0):

There may be no significant difference between resistive respiratory muscle training and threshold inspiratory muscle training on respiratory muscle strength and quality of life subjects with COPD.

VII MATERIALS AND METHODS

This is a quasi experimental study design approved by ethical committe of GSL Medical College and General Hospital .The study was conducted for period of 1 year from july 1st 2024 to june 30th 2025at GSL General Hospital .85 subjects were screened according to inclusion and exclusion criteria 80 subjects were selected randomly allocated through systematic random sampling into 2 groups ,each group containing 40 subjects. Informed consent will be obtained from the participants ,and demographic data will be recorded. Group –A received resistive respiratory muscle trainer (breather) along with conventional physiotherapy and Group –B received threshold inspiratory muscle trainer (philips respironics) along with conventional physiotherapy .subjects received 18 sessions 3 days in a week for 6 weeks**.**PIMAX is for espiratory muscle strength and SGRQ for quality of life was used to evaluate both the groups before and after the intervention .

INCLUSION CRITERIA:

- FEV1/FVC<70%.
- Stage-I and stage-II COPD subjects (GOLD CRITERIA).
- Subjects with COPD are clinically stable .
- PIMAX of <70 cmH2O(maximum inspiratory pressure).
- Subjects who give consent to participate in the study.

EXCLUSION CRITERIA:

- History of cardiovascular diseases.
- Musculoskeletal conditions.
- Psychotropic drugs or abusing alcohol .
- Haemoptysis.
- Uncontrolled hypertension.
- Structural deformities
- Inability or unwilling to sign informed consent

VIII. OUTCOME MEASURES

THE MAXIMAL INSPIRATORY MOUTH PRESSURE (PIMAX) :PIMAX is an index of inspiratory muscle strength . it is measured by using respiratory pressure by manometer . This is a simple and non-invasive method The apparatus to measure the MIP and MEP consists of a mouthpiece with a small orifice (typically 1 mm × 15 mm) to provide a leak and an accurate pressure transducer. The leak is required to prevent the patient from using cheek muscles to perform the maneuvers. The Maximum inspiratory Pressure is usually performed at residual volume, and the Maximum Expiratory Pressure is performed a total capacity.[11]

St. George's Respiratory Questionnaire (SGRQ): It is a Standardized questionnaire to measure quality of life of patients with respiratory disorders. The SGRQ questionnaire designed with 14 questions. Here the total scoring is calculated from '0- 100'. Where score 0 indicates No health impairment and score 100 Maximum health impairment .The St. George respiratory questionnaire can be completed manually or with the aid of computer.[12]

INTERVENTION

GROUP A : RESISTIVE RESPIRATORY MUSCLE TRAINING (THE BREATHER) : The patients are instructed to sit and instructed inhale deeply and forcefully for 2-3 secs ,slight pause then exhale forcefully for 2-3 secs. Patients are then asked to breathe through the breather device beginning with the easiest setting by rotating the inhale and exhale dials at a non fatigable resistance. This process is continued for 10 repetitions for 2 sets. The technique is given for 20-30 minutes in total depending on patients requirements Frequency of breather RMT 3 -times a week will be given ,Breather IMT along with conventional physiotherapy.

FIG:1 Patient performing resistive respiratory muscle training

GROUP B :THRESHOLD INSPIRATORY MUSCLE TRAINING(PHILIPS RESPIRONICS): The patients are instructed to sit comfortably and instructed to breathe through the device for 10-12 repetitions for 2 sets , while the nostrils are occluded with a nose clip . Each inspiration was followed by 2-3 secs hold and exhalation. The technique is given for 20 -30 minutes in total depending on patients requirements .Frequency of threshold IMT -3 times a week will be given, threshold IMT along with conventional physiotherapy.

FIG:2.Patient performing threshold inspiratory muscle training

CONVENTIONAL PHYSIOTHERAPY : Which includes balloon blowing exercises for 3 repetitions for one set ,chest physiotherapy , and then incentive spirometry for 15 reps for 2 sets.

BALLOON BLOWING: Sit in a comfortable position with good posture. Before Starting the exercise gently stretch the balloon a few times to make it easier to inflate**.**Take a slow, deep breath through your nose, filling your lungs completely.Place the balloon in your mouth and exhale steadily, letting the air flow out slowly as the balloon begins to inflate.As the balloon gets bigger, you'll notice it takes more effort to keep blowing. This extra resistance helps strengthen your diaphragm and the muscles around your ribs.[13]

FIG:3 Patient performing balloon blowing exercise.

Chest physiotherapy: chest physiotherapy (CPT) is a treatment technique that combines postural drainage, percussion, and vibration to help clear mucus from the lungs, making it easier to breathe and reducing the risk of lung infections.

Postural drainage:

This uses specific body positions — along with gravity — to help mucus move out of the lungs. Therapist will first listen to the lungs with a stethoscope to figure out where the mucus is. Then, set into a positions that allow gravity to naturally pull the mucus toward the larger airways, where it can be coughed up more easily.

Percussion:

The therapist gently claps on anterior and posteriorly using a cupped hand in a steady rhythm. This loosens the mucus so it can move up through the airways.usually start at the lower part of the lungs and work way upward. [14]

FIG:4 Therapist performing chest percussion

INCENTIVE SPIROMETRY:

Sit comfortably in a chair or propped up in bed. Take the spirometer into the hands and keep it in an upright position Place the mouthpiece in his/her mouth and close lips tightly around it so no air escapes . Inhale gently and steadily through the mouthpiece. As his/her breathe in, the piston inside the device move upward. Try to keep the flow indicator within the "best" or "target" zone . Once full deep breath is taken ,hold it for 3 to 5 seconds. This helps lungs to fully expand and helps keep the tiny air sacs open. Remove the mouthpiece and breathe out naturally. Repeat this procedure for 15 repetitions for 2 sets .[15]

FIG :5 Patient performing incentive spirometry

X. ENROLLMENT

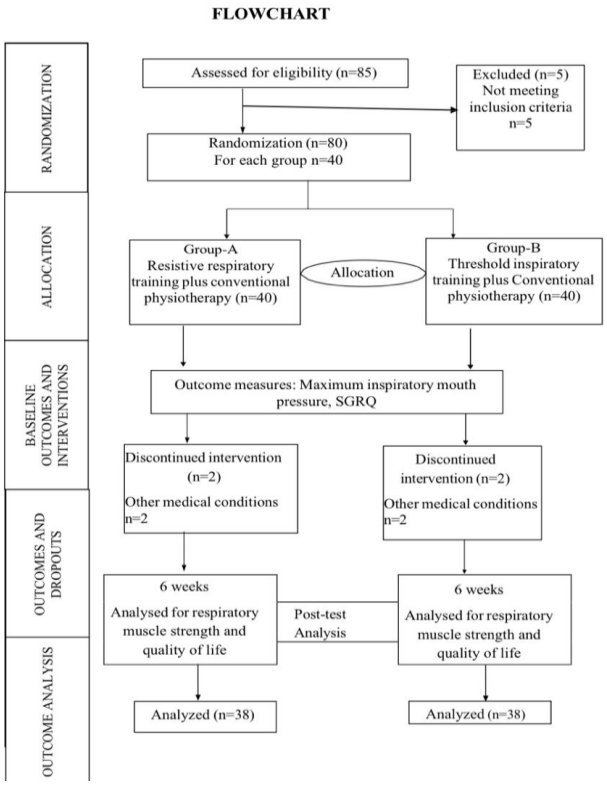

FIG:6 Consort flow chart of study participants from enrollment to analysis

XI .STATISTICAL ANALYSIS

All statistical analysis was done by using SPSS software version 20.0 and MS excel-2019. All descriptive statistical data was presented in the form of mean +/- standard deviations and mean differences were calculated and presented.

Within the groups: Paired student -t test was performed to assess the statistical difference with in the groups for maximum inspiratory pressure , health related quality of life from pre-test and post-test values.

Between the groups: Independent student-t test was performed to assess the statistically significant difference in mean value between the groups for maximum inspiratory mouth pressure for inspiratory muscle strength, St.George"s Respiratory Questionnaire (SGRQ) for health related quality of life. Data also tabulate and graphically represented. For all statistical analysis, $p < 0.05$ was considered as statistically significant.

XII.RESULTS

The Results of the study were analyzed by maximum inspiratory mouth pressure and St. George Respiratory Questionnaire to know the improvement in inspiratory muscle strength and health related quality of life .

The consort flow chart of the study showed the study organization in terms of subjects screening, Random allocation and Analysis following the intervention.

A total of 76 subjects with COPD were screened for eligibility, among 76 subjects were included in the study trail. All the 76 subjects who met the inclusion criteria had undergone baseline assessment and included subjects were randomized into two equal groups consisting of 38 participants in group A and 38 participants in group B. In this study 35 participant's completed training in Group A and 35 participants completed training in Group B with dropouts of 3 in group A and 3 in group B. Comparison was done both within the group as well as in between the two groups so, as to evaluate the intra group and inter group effectiveness of resistive respiratory muscle trainer.

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PI MAX		MEAN	SD	PVALUE	INFERENCE
PRE TEST	GROUP A	59.13	3.80	0.72	In significant
	GROUP B	76.65	3.76		

PI MAX		MEAN	SD	PVALUE	INFERENCE
POST TEST	GROUP A	58.63	5.00	0.0001	Highly significant
	GROUP B	68.31	3.72		

SGRQ		MEAN	SD	PVALUE	INFERENCE
PRE TEST	GROUP A	58.34	5.79	0.64	Insignificant
	GROUP B	58.07	4.68		

SGRQ		MEAN	SD	PVALUE	INFERENCE
POST TEST	GROUP A	41.57	5.26	0.0001	Highly significant
	GROUP B	49.78	4.61		

XIII.DISCUSSION

This is a quasi-experimental study demonstrated that resistive respiratory muscle trainer versus threshold inspiratory muscle trainer on respiratory muscle strength and quality of life on subjects with COPD . To our knowledge, this is the first study to demonstrate that resistive respiratory trainer was more effective than the threshold inspiratory trainer in improving Inspiratory muscle strength and quality of life in subjects with COPD.

In this study copd subjects who underwent resistive respiratory muscle training and threshold inspiratory muscle training along with conventional physiotherapy for 6 weeks ,and the parametres are assessed before and after the interventions. In this study , we are assessed for the maximum inspiratory mouth pressure (pi-max) by using manometer and quality of life by using St. George's Respiratory Questionnaire (SGRQ) . Seventy six subjects were divided into two groups group –A (n=35) received resistive respiratory muscle training (breather) . Group –B (n=35) Threshold inspiratory muscle training (Philips Respironics) , who underwent six week exercise training for three sessions per week .

According to previous studies in copd, they emphasized that continuous resistance helps the breathing muscles adapt more effectively, resulting in better gains in both strength and endurance compared to devices that provide a fixed level of resistance. Similarly, Weiner et al reported that RRMT greatly improved maximal inspiratory pressure (MIP), helped reduce shortness of breath, and boosted exercise tolerance in people with COPD, indicating that it can play an important role in making everyday activities easier and more manageable. [16]

According to Geddes et al. using threshold IMT at the right training intensity can strengthen the inspiratory muscles, reduce breathlessness, and improve exercise tolerance in people with COPD. Their review also highlighted that this type of training is particularly helpful for those with moderate to severe COPD, where weak breathing muscles are a major challenge to daily function.TIMT has also been linked to better exercise performance.[17]

In Group A (Resistive Respiratory Muscle Training), there was a statistically significant improvement at the end of the 6th week in both Pimax (p=0.001) and SGRQ (p=0.001). The exercises in this group effectively enhanced inspiratory muscle strength.

This improvement is attributed to the activation of intercostal muscles and the diaphragm containing specialized muscle spindles. Their contraction triggers a positive feedback loop via the spinal cord, increasing motor drive and inspiratory muscle recruitment under resistance. Additionally, unmyelinated group III and IV afferent fibers (metaboreceptors) detect metabolic changes like lactate accumulation. Though not directly regulating breathing, they influence cardiovascular reflex control. This contributes to enhanced respiratory efficiency and overall functional improvement.[18,19]

Exercises in Group A showed a remarkable increase in SGRQ due to the use of the breather , which provides adjustable resistance during both inspiration and expiration, strengthening the diaphragm, intercostal, accessory, and expiratory muscles. This leads to improved inspiratory (Pimax) and expiratory (Pemax) pressures, enhancing ventilation efficiency and reducing the work of breathing. Consequently, dyspnea and fatigue are reduced, improving the symptom domain of the SGRQ. Enhanced respiratory muscle performance further increases exercise tolerance and functional capacity. These physiological adaptations collectively improve the activity and impact domains of the SGRQ.[20,21]

In Group B (Threshold Inspiratory Muscle Training), there was a statistically significant improvement at the end of the 6th week in both Pi-max (p=0.001) and SGRQ (p=0.001). The increase in Pimax is attributed to the optimization of breathing patterns and reduction of dynamic hyperinflation induced by IMT. Training led to hypertrophy of type II muscle fibers and enhanced inspiratory muscle shortening velocity in COPD patients. IMT shortens inspiratory time, allowing more time for exhalation and lung emptying, thus reducing hyperinflation. These adaptations improve breathing efficiency, reduce breathlessness, and enhance overall functional capacity reflected in SGRQ improvement.[22]

Threshold IMT provides consistent resistance during inhalation, strengthening the diaphragm and accessory respiratory muscles. Increased inspiratory muscle strength reduces the work of breathing, lessening fatigue and breathlessness, thereby improving the symptom domain of the SGRQ. Enhanced endurance and reduced dyspnea enable greater participation in daily activities, improving the activity domain. Strengthened respiratory muscles also decrease exertional breathlessness and fatigue, enhancing psychological well-being and social interaction. Together, these physiological and psychological benefits contribute to a lower total SGRQ score and improved overall quality of life.[23,24,25,26]

The present study shown an improvement in all outcome parameters which include maximum inspiratory mouth pressure , quality of life in both resistive respiratory muscle training and threshold inspiratory training , but when compared to resistive respiratory muscle training and threshold inspiratory muscle training , resistive respiratory muscle training showed more improvement in improving respiratory muscle strength and quality of life .

The result of the present study showed that both groups showed statistically significant difference from pre to post intervention however resistive respiratory muscle training along with conventional physiotherapy showed greater improvements.

In group A PIMAX and SGRQ more statistically significant than group B is may be due to that continuous resistance helps the breathing muscles adapt more effectively, resulting in better gains in both strength and endurance compared to devices that provide a fixed level of resistance.

XIX.LIMITATIONS

1. Small sample size
2. Lack of long term follow up
3. Lack of blinding for evaluators
4. Short duration of intervention

XXI.CONCLUSION

The present study concluded that 6 weeks of resistive respiratory muscle training combined with conventional physiotherapy group and threshold inspiratory muscle training combined with conventional physiotherapy showed significant improvements in improving inspiratory muscle strength and quality of life in subjects with COPD, However Resistive respiratory muscle training combined with conventional physiotherapy is group more effective than threshold inspiratory muscle training combined with conventional physiotherapy. Hence, we conclude that Resistive Respiratory muscle training combined with conventional physiotherapy, safe, inexpensive way for improving inspiratory muscle strength and quality of life in subjects with COPD.

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