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Original Research Article

A PROSPECTIVE STUDY ON INSPIRATORY MUSCLE TRAINING USING DIFFERENT TECHNIQUES TO IMPROVE PULMONARY FUNCTION AND QUALITY OF LIFE IN COPD PATIENTS IN A TERTIARY CARE CENTRE

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Abstract

Background: Respiratory and peripheral muscle dysfunction frequently occurs in COPD patients with extrapulmonary manifestations. Pulmonary rehabilitation, which encompasses exercise training, education, nutritional support, and psychosocial intervention, is the standard treatment for mitigating these diseases. This study aimed to investigate the effects of Inspiratory Muscle Training (IMT) and Peripheral Muscle Training on exercise capacity, quality of life (QOL), and pulmonary function in patients with COPD. **Materials and Methods:** This prospective observational study included 100 patients with COPD at the Government Hospital of Thoracic Medicine, Tambaram Sanatorium, and Stanley Medical College from June 2018 to May 2019. They were randomised into two groups by simple randomisation: inspiratory muscle training and peripheral muscle training. Patient history, including age, sex, family history, physical activity, risk factors, CAT score, BMI, SpO2%, and FEV1%, were assessed. **Results:** Among the 100 participants, 43 in the inspiratory muscle training group and 39 in the peripheral muscle training group completed a 3-week duration of training period. Statistically significant improvements in mMRC dyspnoea grading, CAT score, and 6 MWD were observed in both the inspiratory and peripheral muscle training groups. No significant improvement was observed in SpO2%, BMI, and FEV1% values in either training group. The baseline mean BMI of inspiratory and peripheral muscle training was 23.1±2.4 kg/m2 and 21.7±1.7 kg/m2 respectively, after the training period. **Conclusion:** A three-week training program of inspiratory and peripheral muscle training program showed improvement in quality of life and exercise capacity, whereas no significant improvement was seen in lung function in patients with moderate to severe COPD.

INTRODUCTION

COPD is a common, preventable, and treatable disease that is characterised by persistent respiratory symptoms and airway limitation that is used to treat airway and/or alveolar abnormalities, usually caused by significant exposure to noxious particles and gases.[1] The chronic airflow limitation that characterises COPD is caused by a combination of small airway diseases (obliterative bronchiolitis) and parenchymal destruction (emphysema), and their relative contributions vary from person to person. COPD is confirmed by a lung function test called "spirometry" which measures how much and how quickly a person can forcibly exhale air. The standard respiratory function test for case detection of Chronic Obstructive Lung Disease (COPD) is spirometry.[2] It is one of the most common chronic and disabling diseases and a growing cause of morbidity and mortality.[3]

The gold standard criteria for COPD include indicators that increase the probability of a COPD diagnosis, such as dyspnoea that is progressive over time, characteristically worse with exercise, and persistent. Chronic cough that may be intermittent and may be unproductive and recurrent wheeze

chronic sputum production in which any pattern of chronic sputum production may indicate COPD.[4] The history of risk factors includes host factors (such as genetic factors, congenital/ developmental abnormalities etc.), tobacco smoke (including popular local preparation), smoke from home cooking and heating fuels, occupational dusts, vapours, fumes, gases and other chemicals and the family history includes low birth weight, childhood respiratory infections etc.[5]

It is well-established that the inspiratory muscles (mainly the diaphragm) deteriorate in patients with pulmonary emphysema. Based on respiratory mechanics, the respiratory muscles (both inspiratory and expiratory) are subjected to heavy duty under adverse conditions. From a metabolic point of view, although under normal conditions, the nutrient and oxygen demands of respiratory muscles are relatively low, and in patients with COPD, they become progressively higher as a negative consequence of their increase in workload.[6] This is of most importance in COPD patients whose oxygen delivery to these muscles can be readily compromised by simultaneous gas exchange abnormalities occurring in the lungs.

Although lower-limb muscle dysfunction appears to be a localised problem in patients with COPD, it has a direct and severe impact on exercise capacity, which is characterised by a reduction in muscle strength, endurance, and efficiency of muscle metabolism. This modification is more significantly seen in lower limb muscles of COPD patients, as it requires more oxygen for increased workload which in turn results in increased lactate production.[7]

Pulmonary rehabilitation is an extensive management program specifically designed for patients with COPD, demonstrating significant clinical benefits in reducing dyspnoea, enhancing quality of life, and increasing exercise capacity. Numerous studies have verified that consistent exercise interventions lasting over 6 weeks can significantly enhance peripheral skeletal muscle strength and exercise capacity in individuals with stable COPD.[8] There is substantial evidence that exercise training, which is a fundamental component of pulmonary rehabilitation, enhances exercise tolerance, reduces dyspnoea sensations, improves functional capacity, and boosts the quality of life in patients with severe chronic obstructive pulmonary disease.

Aim

This study aimed to investigate the role of Inspiratory Muscle Training (IMT) and Peripheral Muscle Training as adjuvant therapies to improve exercise capacity, Quality of Life (QOL), and pulmonary function among COPD patients.

MATERIALS AND METHODS

This prospective observational study was conducted on 100 COPD patients at the Government Hospital of Thoracic Medicine, Tambaram Sanatorium, and the Department of Respiratory Medicine, Stanley Medical College, Chennai, from June 2018 to May 2019 for 12 months. The study protocol was approved by the Institutional Ethics Committee, ethical committee clearance was obtained, and informed consent was obtained from all patients.

Inclusion Criteria

Patients with symptoms, risk factors, and spirometry findings suggestive of moderate-to-severe COPD (FEV/FVC <0.7; post-bronchodilator FEV < 80%) were included in the study.

Exclusion Criteria

Patients with extremities of age, respiratory failure, post-tuberculosis sequelae, unstable angina, haemoptysis, skeletal deformities, severe hypertension, cardiac failure, and those who were unwilling to participate were excluded from the study.

Methods

A total of 100 patients with COPD were randomised by simple randomisation into two groups: 50 patients in the inspiratory muscle training (IMT) group (using THRESHOLD ®, inspiratory muscle trainer device) and 50 patients in the peripheral muscle training (PMT) group (using THERABAND ® elastic resistance loop).

In the inspiratory muscle training (IMT) group, seven patients dropped out due to clinical improvement before the completion of training (n=5) and other/personal reasons (n=2). Finally, 43 patients were included in the inspiratory muscle training group.

In the peripheral muscle training (PMT) group, 11 patients dropped out because of clinical improvement before the completion of training (n=6) and other/personal reasons (n=5). Finally, 39 patients were included in the inspiratory muscle training group.

Patient history, including demographic profiles such as age, sex, occupation, smoking status, symptoms, and duration of the presenting illness, and vital parameters such as pulse rate, respiratory rate, SpO2%, blood pressure, temperature, and Body Mass Index (BMI) were assessed. Each training session lasts for 15-20 mins, six days a week, for three weeks.

The following parameters were measured at baseline and after completion of the 3-week training program. The mMRC dyspnoea score, COPD Assessment Test (CAT) score, and Body Mass Index (BMI) were assessed as measures of quality of life, 6 Minute Walking Distance (6 MWD), oxygen saturation (SpO2) was assessed as a measure of exercise capacity, and Forced Expiratory Volume in one second (FEV1) was assessed as a measure of lung function.

Statistical Analysis

Data were presented as frequencies, percentages, means, and standard deviations. Continuous variables were assessed using the paired t-test. Statistical significance was set at $p<0.05$.

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RESULTS

In the inspiratory muscle training group, 79% (n=34) and 21% (n=9) of the patients were males and females respectively, and in the peripheral muscle training group, 76.9% (n=30) and 23% (n=9) of the patients were males and females respectively. Among the males in the inspiratory muscle training group, 74.3% (n=29) and in the peripheral muscle training group, 73.3% (n=22) were smokers. Among the females in the inspiratory muscle training group 88.9% (n=8) and in the peripheral muscle training group 100% (n=9) were exposed to either biomass or passive smoking. The mean age of those enrolled in the inspiratory muscle training group was 60.4 years and that in the peripheral muscle training group was 58.3 years. [Table 1]

In mMRC dyspnoea grading, both groups showed a significant reduction in dyspnoea severity, with the IMT group improving from 2.5±0.6 to 1.6±0.6 (p=0.013) and the PMT group from 2.3±0.7 to 1.4±0.7 (p=0.019). Significant improvements in COPD symptoms were observed in both groups, with the IMT group reducing their CAT scores from 23±5 to 15±5 (p=0.003) and the PMT group from 21±4 to 14±5 (p=0.004). The mean 6 MWD at baseline in the inspiratory and peripheral muscle training group increased from baseline of 415.6±9.5 m to 441.1±81.4 m (p=0.055) and from 422.8±76 m to 461.3±75 m (p=0.032) respectively which was statistically significant.

The baseline mean BMI of inspiratory and peripheral muscle training was 23.1±2.2 kg/m2 and 21.8±2.4 kg/m2 respectively, after the training period no significant change in BMI (p=0.994, p=0.897 respectively). The baseline mean SpO2 in the inspiratory and peripheral muscle training groups was 96.7±1.8% and 96.4±2.1%, respectively, after the training period, and there were no statistically significant changes in SpO2 values (p=0.782 and p=0.661, respectively). The mean FEV1% in the inspiratory and peripheral muscle training group at baseline were 49.1±10% and 46±9.9% after the training period there were no statistically significant improvements (p=0.398, p=0.709 respectively). [Table 2]

Table 1: Demographic details of the patients

		Groups (%)	
		IMT	PMT
Gender	Male	34 (79%)	30 (76.9%)
	Female	9 (21%)	9 (23.1%)
Smokers in male	Smokers	29 (74.3%)	22 (73.3%)
	Non-smokers	10 (25.7%)	8 (26.7%)
Passive smokers in female	Biomass exposure/ passive smoking	8 (88.9%)	9 (100%)
	No H/O of biomass exposure/ passive smoking	1 (11.1%)	0 (0%)
Age (mean±S.D)		60.4±9	58.3±10.1

Table 2: Comparison of various parameters between the groups

	Groups (mean)					
	Inspiratory muscle training			Peripheral Muscle Training		
	Before	After	P-value	Before	After	P-value
mMRC dyspnoea grading	2.5±0.6	1.6±0.6	0.013	2.3±0.7	1.4±0.7	0.019
CAT score	23±5	15±5	0.003	21±4	14±5	0.004
6 MWD (in meters)	415.6±79.5	441.1±81.4	0.055	422.8±76	461.3±75	0.032
BMI (kg/m2)	23.1±2.2	23.1±2.4	0.994	21.8±1.8	21.7±1.7	0.897
SpO2%	96±2.1	96.7±1.8	0.782	95.7±2.5	96.4±2.1	0.661
FEV1%	49.1±10	51±10.2	0.398	46±9.9	46.8±9.4	0.709

DISCUSSION

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality, worldwide. COPD is characterised by persistent expiratory flow limitation which is usually progressive.[9] Dyspnoea is the most prominent exercise-limiting symptom of the disease, which leads to chronic avoidance of physical activities. Consequently, low physical activity levels contribute to skeletal muscle deconditioning and exercise capacity reduction, which impact negatively on health-related quality of life.[10]

Inspiratory muscle and peripheral muscle dysfunction are extrapulmonary manifestations that are often present in patients with COPD. Pulmonary rehabilitation can effectively delay the decline of pulmonary function and improve exercise capacity in COPD patients.[11] Pulmonary rehabilitation including exercise training, education, nutritional intervention and psychosocial support is standard care for patients with COPD to counteract extrapulmonary disease manifestations

In our study, the mean mMRC dyspnoea grading of the inspiratory muscle training group and peripheral muscle training group were baseline 2.5±0.6 and 2.3±0.7 respectively after the training period it was 1.6±0.6 and 1.4±0.7 with a p=0.013 and 0.019 respectively, both the groups show a statistically significant decrease in the severity of dyspnoea. This is similar to the results reported by Riera et al. and Lisboa et al. In their studies, inspiratory muscle training showed statistically significant improvement in dyspnoea scores with p<0.003 and p<0.05 respectively.[12,13]

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In this study, the mean CAT scores of the inspiratory and peripheral muscle training groups were 23±5 and 21±4.25, respectively. After the training period, it was 15±4 and 14±4.5, with p=0.003 and p=0.004, respectively, and both groups showed statistically significant decreases in CAT scores. Greulich et al. conducted a study and reported that peripheral muscle training shows improvement in CAT score from 19.16±6.37 to 14.46±7.37 with a p=0.056.[14]

In our study, the p-values for the 6 MWD of the inspiratory muscle training group and peripheral muscle training group were p=0.055 and p=0.032, respectively, and both groups showed statistically significant improvement, which was much more significant in the peripheral muscle training group than in the inspiratory muscle training group. Similarly, Wu et al. reported that peripheral muscle resistance training showed statistically significant improvement in 6 MWD (baseline of 432.06±52.78 m to 478.91±48.93 m) with p=0.006 in their study.15 In contrast, Shahin et al. reported that inspiratory muscle training showed statistically significant improvement in 6MWD.[16]

In this study, the mean BMI of the inspiratory muscle training group and peripheral muscle training group are baseline 23.1±2.2 and 21.8±1.8 respectively after the training period it was 23.1±2.4 and 21.7±1.7 with a p = 0.994 and p = 0.897 respectively, both the groups has not shown statistically significant improvement. Improvement in BMI was expected due to improvement in nutritional status, exercise capacity, and decreased severity of dyspnoea.

In this study mean SpO2 of the inspiratory muscle training group and peripheral muscle training group are baseline 96±2.1 and 95.7±2.5 respectively after the training period it was 96.7±1.8 and 96.4±2.1 with a p = 0.782 and p=0.661 respectively, both the groups has not shown statistically significant improvement. This result follows Scherer et al. study also shows no significant improvement in maximal oxygen consumption (V O2 MAX).[17]

In this study mean FEV1% of the inspiratory muscle training group and peripheral muscle training group are baseline 49.1±10% and 46±9.9% respectively after the training period it was 51±10.2% and 46.8±9.4% with a p=0.398 and p=0.709 respectively, both the groups have not shown statistically significant improvement. These results follow the Shahin et al.16 study with no significant improvement in FEV1% (baseline of 33.6±8.04 to 33.09±9.6, p = 0.849) and Wu et al. study with a p =1.09.15

Limitations

A small number of subjects and no control group were included; hence, the outcome of COPD patients without these interventions is unknown. There were a few female patients, which was due to both under-diagnosis and a lower prevalence of COPD among the female population. Poor adherence, being inpatient training keeping them in the hospital until the completion of the training program, was more challenging despite adequate and frequent counselling about these trainings. Inspiratory and peripheral muscle training were studied as individual training groups, but the combined efforts of these two training programs could not be ascertained.

CONCLUSION

In conclusion, both inspiratory and peripheral muscle training play a pivotal role in improving the severity of dyspnoea, quality of life, and exercise capacity in patients with moderate-to-severe COPD; however, no significant improvement in lung function was evident in this study.

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