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Research

Effect Of Inspiratory Muscle Training On Exercise Tolerance And Quality Of Life In Post Covid-19 COPD Patients

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory lung disease that leads to obstructed airflow from the lungs caused by long term exposure to irritating gases or particulate matter. Diaphragm muscle, the main inspiratory muscle, is associated with weakness in COPD patients. On the other hand, patients who are currently having COPD with a history of Covid-19 has more negative impact on the diaphragm muscle thereby limiting the exercise tolerance in patients due to dyspnoea and hence, will ultimately reduce the quality of life. Therefore, this study aim to evaluate the effectiveness of inspiratory muscle training on exercise tolerance and quality of life in post covid-19 COPD patients. Forty-one subjects with an age group of 45-60 years having post covid-19 COPD were recruited for the study. Pre and post evaluation of 6MWT and SGRQ-C for exercise tolerance and QOL respectively was taken from each patient at the baseline and at the end of 4th week. For both the outcomes, the p-value comparing pre-test and post-test results of post Covid-19 COPD patients is <0.001, indicating a statistically significant difference within the group.

Keywords: COPD; Post Covid-19; Inspiratory Muscle Training; Exercise Tolerance; Quality of Life.

INTRODUCTION

A heterogeneous lung condition, chronic obstructive pulmonary disease (COPD) is characterized by persistent respiratory symptoms such as cough, dyspnoea, and expectoration with or without airway abnormalities that cause persistent, often progressive airflow obstruction due to significant exposure to noxious particles or gases. The two primary risk factors in high-income nations are smoking and indoor cooking/occupational exposures respectively, while in low- income countries, occupational exposures and smoking comprise the major risk factors.

When a cluster of problems affects the lung parenchyma and airways together, it is commonly referred to be COPD and this causes restriction to expiratory airflow[1]. Prolonged inflammation results in structural alterations, constriction of the minor airways, and damage to the lung parenchyma, which causes the alveolar attachments to the small airways to disappear and reduces the elastic recoil of the lungs. Consequently, these modifications lessen the airways' capacity to stay open during expiration[2].

A hallmark aspect of COPD is mucociliary dysfunction and airflow limitation, which might be attributed to a loss of tiny airways. Diaphragm dysfunction occurs with every stage of the development of COPD. Diaphragm function in individuals with COPD has been extensively studied, and it has been shown that dyspnoea and, eventually, exercise intolerance are associated to inspiratory muscle weakness. Dyspnoea reduces an individual's ability to exercise and lowers their quality of life in COPD sufferers. Studies have indicated that patients with mild to moderate COPD had a 30% decrease in myosin heavy chain concentration, which is indicative of diaphragmatic atrophy, a significant clinical basis of dysfunction. Patients with COPD experience a decrease in the cross-sectional area of diaphragm muscle fibre, a change in muscle fibre type from fast twitch muscle (type II) to slow twitch muscle (type I), and a reduction in diaphragm muscle length due to pulmonary hyperinflation, which ultimately leads to a decline in diaphragm muscle strength. Extreme clinical symptoms have been linked to COVID-19, primarily in patients with a history of metabolic illnesses such as diabetes and long-term respiratory conditions including asthma and COPD. Research indicates that COVID-19 primarily affects the lung, causing a variety of pathophysiological events such as the breakdown of the diffuse alveolar epithelium, the creation of hyaline membranes, bleeding and damage to capillaries, the proliferation of alveolar septal fibrous tissue, and pulmonary consolidation. This virus reduces lung compliance, damages the lung parenchyma in an inflammatory manner, and may result in an even more pronounced imbalance in the RM force-generating capacity (PI_{max}).[3]

One of the most significant skeletal muscles regulating lung capacity and respiratory efficiency that has been impacted by COVID-19 is the diaphragm, which is the main muscle of respiration. The respiratory system is substantially impacted by post-COVID-19, which damages alveoli and arteries and is characterized by dyspnoea, coughing, weakening in the inspiratory muscles, and anxiety or sadness. Additionally, research revealed that up to 30% of COVID-19 survivors experience dyspnoea during exercise, which keeps the majority of them from going back to their previous jobs and way of life. Some clinical features that can be seen in these patients include progressive dyspnoea, cough and sputum, barrel chest deformity, use of accessory muscles [example: sternocleidomastoid, pectoralis major and minor, serratus anterior, latissimus dorsi and trapezius], decreased breath sounds, reduced functional exercise capacity and oxygen desaturation.[4]

METHODOLOGY

The study was conducted at Rajarajeswari Medical College and Hospital (RRMCH), Physiotherapy Department, Bangalore. Referral was obtained from Pulmonology Department, RRMCH, Bangalore. Forty- one subjects were included in the study for a total duration of 10 months. Subjects with age between 45-60 years who was diagnosed with grade 2 COPD along with a history of post covid-19 were included. Subjects with a history of chest pain, recent rib fracture, recent abdominal surgeries, hypertension, pregnancy, diagnosed COPD with no history of covid-19 infection, any neurological disorders, any other cardiorespiratory disorders and any structural or musculoskeletal disorder of the spine were excluded from the study.

Procedure

Pre- Intervention

On the first day before performing the inspiratory muscle training, the subject's assessment was taken and then the subjects were asked to perform the 6-minute walk test. After completion of the test, subject's saturation and pulse rate was measured by a pulse oximeter and asked them to marked their level of exertion as well as filling up the SGRQ-C questionnaire.

Intervention

Inspiratory muscle training: Device disinfectant protocol

- The device was first cleaned with warm soapy water
- Soaked in 3% of hydrogen peroxide for 20 minutes
- Then, it was rinsed with distilled water
- Finally, the device was tap dry and air dry in a clean environment.

Inspiratory muscle training was performed through an inspiratory muscle training device called IMT threshold device. Initially, the subjects were asked to sit in an upright posture and was advised to hold the device by the handle grip and place the mouthpiece in their mouth. Demonstration was shown to the subject prior to the training. Initially, the patients were asked to exhale through mouth then a nose clip was clipped over their nose. After that, they were asked to inhale and exhale through their mouth using a threshold IMT trainer. The procedure was repeated for 30 breaths with a rest period of 10 seconds after every 10 breaths with a total of 6 cycles repetition for a total duration of 20 minutes per session. Intervention was for a total of 4 weeks, with a frequency of 5 times per week.

Post- Intervention

At the last day of intervention, that is, on the last day of the 4^{th} week, the subjects were again asked to perform the 6-minute walk test and filled up the questionnaire and therefore, the values were then taken from both pre- intervention and post-intervention for statistical analysis.

OUTCOME MEASURES

6 Minute Walk Test (6MWT)

6MWT is a valid and reliable method of assessing functional ability and it is a sub-maximal exercise test which is used to assess aerobic capacity and endurance. The 6MWT should be performed preferably indoors, on a flat, straight, hard-surfaced corridor that is at least 30 m long. The patient was told to be calm, taken his/her medications and wear comfortable clothing and shoes. Recordings of oxygen saturation, heart rate and blood pressure and the Borg scale rating for dyspnoea were taken. Once the patient has understood the instructions, he/she is ready to begin the test. The walking course must be marked every 30 m and it is advisable to place cones in the turn-arounds. During the test the participants have to walk at a rate suitable to their condition and they are allowed to stop or slow down if they feel like doing so and resume walking as soon as possible[5].

St George Respiratory Questionnaire (SGRQ-C)

The St George's Respiratory Questionnaire (SGRQ - C) is a shorter version of the original SGRQ which has a good psychometric property comparable to those of the original version and has strong evidence of validity, reliability and responsiveness towards disease severity in COPD patients used to evaluate the health-related quality of life of patients with chronic respiratory diseases. It is a multi-dimensional instrument that is composed of three domains: Symptoms, Activity and Impact. Part 1 of the questionnaire addresses the frequency of respiratory symptoms which is usually used in assessing the patient's perception of their recent respiratory problems[6].

Part 2 of the questionnaire addresses the patient's current state (i.e., how they are these days). The Activity score measures disturbances to daily physical activity. The Impacts score covers a range of disturbances of psycho-social function. Validation studies for the original SGRQ showed that this component relates in part to respiratory symptoms, but it also correlates quite strongly with exercise performance (6-minute walking test), breathlessness in daily life (mMrc breathlessness score) and disturbances of mood (anxiety and depression).

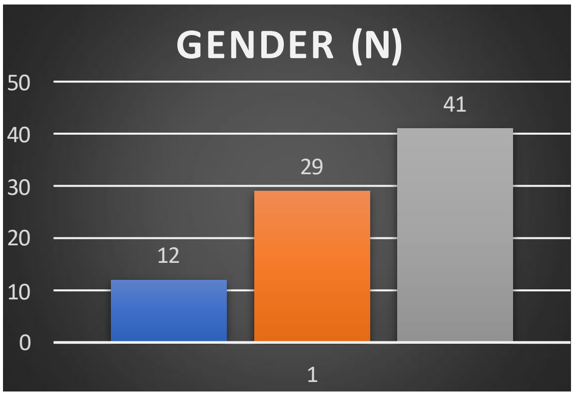
STATISTICAL ANALYSIS

Data was analysed using the statistical package SPSS 27 and level of significance was set at $p<0.05$. MS Excel and MS Word software was used to generate tables and graphs. Descriptive statistics was performed to assess the mean and standard deviation for the continuous data like age, gender, measures of the 6minute walk test and the SGRQ-C. Shapiro-Walk test was used to test the normality of the data. Based on the normality of the data, a Paired T-test was used to compare the Pre-test and Post test values within the group.

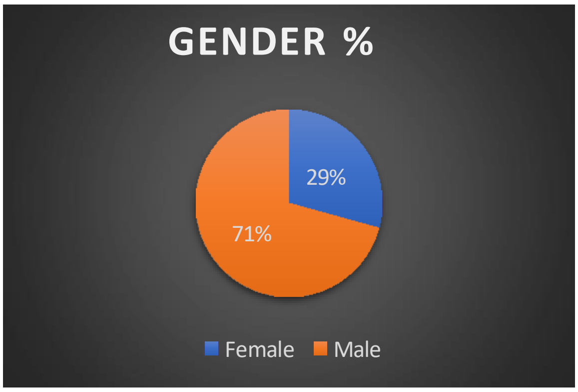
Table 1: Gender Distribution

Parameter	N (%)
Gender	
Female	12 (29.3)
Male	29 (70.7)
Total	41 (100)

RESULTS



Graph 1: Distribution of Gender Numbers

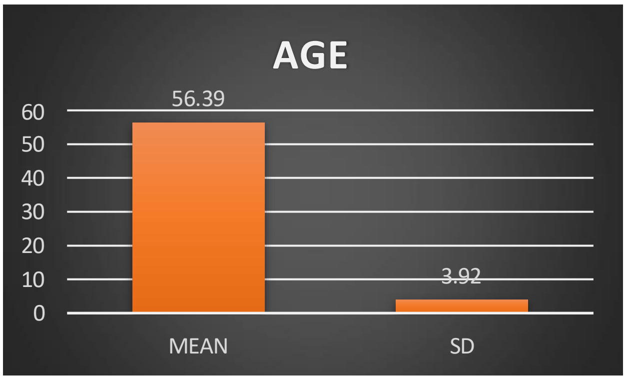


Graph 2: Distribution of Gender in expressed in percentages

In the present study, TABLE 1 shows the distribution within the group that represents 41 participants where 12 (29%) were females and 29 (71%) were male (GRAPH 1 and GRAPH 2).

Table 2: Mean And Standard Deviation Of Age

Parameter	Mean	Sd
Age	**56.39**	**3.92**

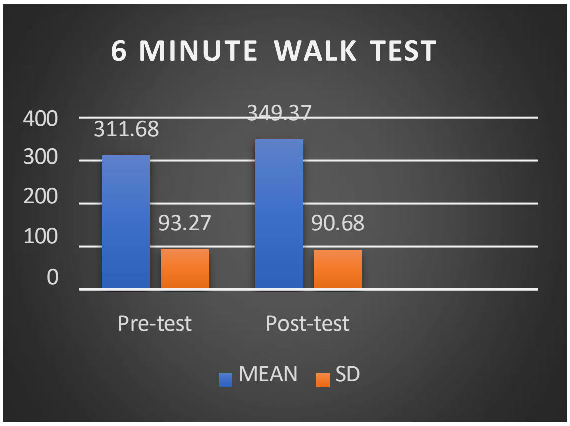


Graph 3: Mean and SD of Age

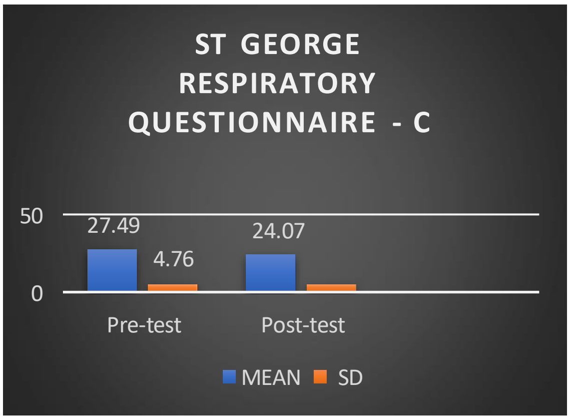
Table 2 provides the descriptive statistics for the parameter of age that was expressed as mean ± standard deviation. The mean age of the participants is 56.39 years, with a standard deviation of 3.92. This indicates that the participant's ages vary around the mean by approximately 3.92 years (Graph 3).

Table 3: Mean And Standard Deviation Of Outcome Measures

S. NO	Parameter	Mean ± Standard Deviation
1	6 Minute Walk Test	
	Pre- Test Value	311.68 ± 93.27
	Post – Test Value	349.37 ± 90.68
2	St George Respiratory Questionnaire-C	
	Pre-Test Value	27.49 ± 4.76
	Post-Test Value	24.07 ± 4.79



Graph 4: Mean And SD of Pre-test and Post-test values of 6Minute Walk Test



Graph 5: Mean an SD of Pre-test and Post- test values of SGRQ-C

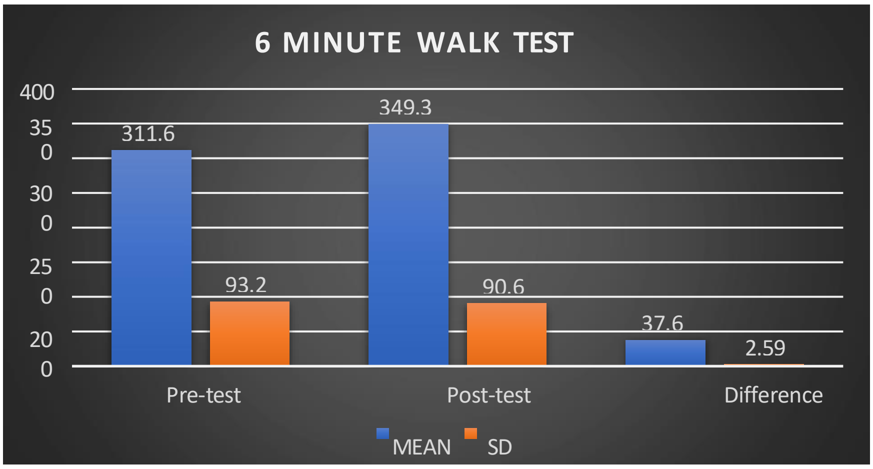
Table 3 represents the average of the 6 Minute Walk Test and the St. George Respiratory. Questionnaire-C which include both pre-test and post-test values that is expressed as means ± standard deviations. In the 6 Minute Walk Test, the mean pre-test value is 311.68, with a standard deviation of 93.27 and mean post-test value is 349.37, with a standard deviation of 90.68 (GRAPH 4). Among the St George Respiratory Questionnaire-C, the results show a mean pre-test value of 27.49 with a standard deviation of 4.76 as well as a mean post-test value of 24.07 with a standard deviation of 4.79 (Graph 5).

Table 4: Comparison Of Pre And Post Intervention

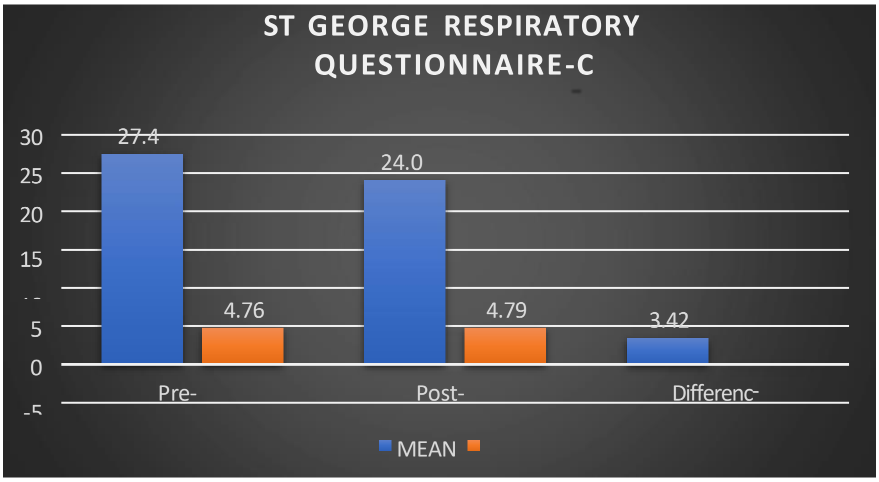
S.No.	Parameter	Pre- Test	Post- Test	Difference	P-Value
		Mean ± Standard Deviation		Mean ± SD	
1	**6 Minute Walk Test**				
	Pre-Test vs. Post-Test	311.68 ±93.27	349.37 ±90.68	37.69 ± 2.59	<0.001*
2	**St George Respiratory Questionnaire-C**				
	Pre-Test vs. Post-Test	27.49 ±4.76	24.07 ±4.79	3.42 ± 0.03	<0.001*

*P-Value <0.05 – Significant**

Table 4 compares the pre-test and post-test values of the 6-Minute Walk Test score and the St George Respiratory Questionnaire-C score, along with the corresponding p-values indicating the significance of improvement. The mean pre and post-test value for 6 Minute Walk Test was 311.68 ± 93.27 meters and 349.37 ± 90.68 meters respectively. The results of St George Respiratory Questionnaire-C scores show a mean pre-test value of 27.49 ± 4.76 and a mean post-test value of 24.07 ± 4.79. The p-value comparing pre-test and post-test results of post Covid-19 COPD patients is <0.001, indicating a statistically significant improvement of exercise tolerance with the mean difference of 37.69 meters (GRAPH 6) and reduction of respiratory impact on the quality of life with a mean difference of 3.42 (Graph 7).



Graph 6: Mean And SD Differences of Pre-test and Post-test Values Of 6 Minute Walk Test



Graph 7: Mean And SD Differences of Pre-test and Post-test Values of SGRQ-C

DISCUSSIONS

COPD is a disease that occurs in later life, and is associated with multiple comorbidities including cardiovascular diseases. Evidence suggests that COPD itself is linked to worse outcomes, in addition to the risk posed by age and comorbidities[9]. Patients with COPD are considered to be at high risk for developing severe respiratory symptoms following COVID-19 infection[10]. This could be due to pre-existing reduced pulmonary function or greater vulnerability to viral infection (by weakened antiviral defence or elevated ACE2 expression) in COPD. However, the primary symptom of COPD associated with post-Covid 19 limits exercise capacity and increased dyspnoea, which eventually results in a chronic intolerance to physical activity and a lower quality of life[11]. Therefore, this study aimed to improve the exercise tolerance and quality of life in COPD patients who had a history of Covid-19 by implementing Threshold Inspiratory Muscle Training for a total duration of 4 weeks to find out whether this intervention helps in improving the exercise tolerance and quality of life in post-Covid 19 COPD patients or not. 41 patients who participated in the study had a similar baseline parameter of MMRC scale of 3-4 prior to intervention program. Inspiratory muscle training is a technique used for improving the inspiratory muscle strength, mainly the diaphragm muscle. Studies showed that in COPD, inspiratory muscle weakness leads to dyspnoea making the patients to stay away from physical activity[12-15]. The reduction of physical activity further leads to deconditioning of the lower limb muscles indicating an exercise intolerance in those patients. Therefore, IMT training strengthens the diaphragm muscle which in turn reduces the dyspnoea level and improves the exercise tolerance of patients.

6MWT and SGRQ-C was used as an outcome measure to evaluate the improvement of symptoms prior and after the treatment. Hence, table 2 and 3 shows that male participants were more in comparison to female participant. This could be due to the high prevalence of smoking in males.[16] Stated that in order to prevent COPD, it is important to create awareness amongst the community regarding cessation of smoking and prohibiting to smoke in public places so as to reduce the smoke exposure. Table 4 showed improvement in the walking distance from a mean of 311.68 to 349.37 meters after the treatment as well as a reduction in the SGRQ-C score from a mean of 27.49 to 24.07 post treatment indicating an increased walking distance and better respiratory health respectively[17]. Furthermore, table 5 evaluates the significant difference between the pre and post intervention of 6MWT with a difference of 37.69 and SGRQ-C of 0.03. The improvement of the outcomes can be due to the resistance training provided by IMT which results in better elasticity, increased strength, power, and diaphragm's endurance over time. Thus, the diaphragm movement becomes more pronounced, improving its respiratory activity.[18] supports the use of IMT in order to improve the exercise tolerance usually experienced by post covid-19 patients which is similar to the findings of this study. Therefore, the present study showed the overall results based on the objective of the study suggesting that Inspiratory Muscle Training aids in improving exercise tolerance and the quality of life in post-COVID-19 COPD patients.
Hence, the alternate hypothesis is accepted.

Limitation And Strength of The Study

- Time duration of the study is limited
- Sample size is small
- All the participants got enrolled in the intervention program
- The follow-up of all participants was obtained under supervision.

CONCLUSION

This study was undertaken to evaluate the effectiveness of Inspiratory Muscle Training in improving the exercise tolerance and quality of life in post covid-19 COPD patients. It was a one group study and the data was collected pre and post intervention for the analysis. The result of the study shows that there were statistical improvements on both the exercise tolerance as well as the quality of life in post covid-19 COPD patients. Therefore, IMT is a feasible and advantageous device that can be used for improving the respiratory symptoms in post covid-19 COPD patients.

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