International Journal of Medical Science in Clinical Research and Review
Online ISSN: 2581-8945
Available Online at http://www.ijmscrr.in Volume 05|Issue 05 (September-October)|2022|Page: 434-441
Pubmed **NLM ID:** 101768774 **SJIF Impact Factor:** 5.782

Original Research Paper

Effectiveness of breathing exercises on oxygen saturation in Post COVID patients; a prospective study

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Article Received: 25-07-2022 **Revised:** 15-08-2022 **Accepted:** 06-09-2022

ABSTRACT

Introduction: Restrictive ventilatory deficit (pulmonary fibrosis) is one of the most common problems seen in patients surviving coronavirus disease 2019 (COVID-19). These patients were found to be unable to maintain peripheral oxygen saturation (SpO2) above 94% and also reported fatigue and fall of SpO2 on exertion. Early pulmonary rehabilitation of these patients may reduce long term complications.

Methodology: The study was conducted in 50 patients who were recruited from the post COVID-19 OPD of a tertiary care teaching hospital in central India. The participants were advised breathing exercises (diaphragmatic breathing exercise, segmental chest expansion exercises, incentive spirometry and pranayama) for three months and results were evaluated by 6 minutes- walk test (SPO2, distance covered during 6MWT and the product of distance covered during 6MWT and weight).

Results: Results demonstrated significant improvement in clinical symptoms as well as SpO2. Baseline pre-walk SpO2 was 94.2 ± 0.78 and the post-walk SpO2 was 93.6 ± 0.88, both of which showed significant improvement at the end of 3 months (98.08 ± 1.24 (p=0.001) and 97.76 ± 1.17 (p=0.002) respectively). The distance as well as the product of distance covered and weight during 6MWT also showed significant improvement at the end of 3 months.

Conclusion: The results of the study enable to give a proposition that along with medical treatment, chest physiotherapy (breathing exercises) must be implemented at the earliest which significantly improves pulmonary function in post-COVID patients.

Key words: Post COVID-19, SpO2, breathing exercises.

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), resulting in coronavirus disease 2019 (COVID-19), has caused unparalleled morbidity and mortality worldwide.[1] Early studies have shown symptoms such fatigue, dyspnoea, chest pain, arthralgia and cognitive disturbances as residual effects of SARS-CoV-2 infection. [2] Cellular damage, a robust

innate immune response with inflammatory cytokine production, and a pro-coagulant state induced by SARS-CoV-2 infection may contribute to long term complications. [3] Recent studies have shown that the most commonly affected organ by coronavirus is lung, with pathologies including alveolar epithelium destruction, hyaline membrane formation, pulmonary consolidation and fibrosis. Persistent fibrosis often leads to restrictive ventilatory dysfunction lasting for months.[4] The pathophysiology of COVID 19 begins with an asymptomatic phase wherein the virus undergoes local replication, propagation and infection of the ciliated cells in the conducting airways followed by invasion of upper and lower respiratory tract progressing to ARDS (acute respiratory distress syndrome). Post COVID pulmonary fibrosis is a known sequalae to ARDS, persistent radiological abnormalities with compromised lung ventilation have been a major complication in most of the post COVID patients.[5] Various treatment strategies are being under evaluation, and anti-fibrotic drugs are judiciously being used with major benefits in reducing fibrotic damage driven by immune dysregulation.[6] However, studies show that the discharged survivors of COVID-19 are presenting with restrictive ventilatory defects. In the study done by Alessia Fumagalli et al, assessed the pulmonary function test at the time of clinical recovery and six weeks after discharge in the survivors of COVID-19 found FEV1 and FVC were lower, while FEV1/FVC was higher. After 6 weeks pulmonary function improved but FVC was still lower.[7] Pulmonary rehabilitation can thus be beneficial in early stages of the disease as it not only improves the respiratory function but also increases exercise endurance and ability to perform of the daily routine activities.[8] Breathing exercises such as diaphragmatic breathing, Segmental chest expansion, Pranayama are known to improve ventilation, promote airway clearance, improve the strength, endurance & coordination of the muscles of ventilation, promote relaxation and relive stress. Incentive spirometry, a chest expansion technique, is commonly used for pre- and post-operative patients, as well as patients with pneumonia, acute chest syndrome, COPD exacerbations, and ARDS.[9] These simple exercises could have a positive impact in post COVID patients enabling to hasten recovery from illness. The present study was designed to analyse the effectiveness of breathing exercises (chest physiotherapy), incentive spirometry on the pulmonary function after three months in the post COVID patients who presented with fatigue, breathlessness and Spo2 falling to < 95% with exertion or some with daily routine activities

MATERIAL AND METHODS:

The present study was conducted in patients recruited from the post COVID-19 OPD, at a tertiary care teaching hospital in central India from October 2020 to December 2020. Study was initiated after being approved by the Institutional Ethics Committee. Written informed consent was taken prior to the study after explaining the purpose of the study.

Study population

Male patients (n=50) who recovered from COVID 19 attending to post COVID-19 OPD fulfilling the following criteria were included in the study; (a) age between 25-45 years. (b) Presenting with symptoms of fatigue, O2 saturation falling to less than 95% on more than normal routine work and (c) Restrictive pattern in Pulmonary function test. Patients who were smokers, diabetic, had any other respiratory illness, cognitive impairment, and hearing or vision impairment or involved in any other study were excluded from the study.

Study procedure

After selection of the participants, their baseline demographic parameters were noted and were subjected to 6-minute walk test (6MWT). Patients were asked to wear comfortable cloth or surgical mask

during the test. Pre and post-test oxygen saturations were measured by pulse oximeter and the distance covered by the patient was noted. Patients were also evaluated clinically. Patients were advised to do following breathing exercises daily for a period of 3 months.

1) D**iaphragmatic breathing exercises:** For performing this exercise, participant sits comfortably with knees bent and shoulders, head and neck relaxed. He places one hand on the upper chest and the other just below the rib cage and breathes in slowly through nose so that the stomach moves out against the subject's hand. Participants were asked to do 10 repetitions, 3 times a day.
2) **Segmental chest expansion exercises**: The subject is asked to breathe out, and feel the rib cage move downward and inward. As he breathes out, place firm downward pressure into the ribs with the palms of your hands and just prior to inspiration, apply a quick downward and inward stretch to the chest.
3) **Incentive spirometry**: The subject is asked to sit relax and hold the instrument at eye level, placing the mouth piece into the mouth, the subject has to breathe in through the mouth by sucking on the apparatus tube. It moves the balls in the upward direction. Subject is advised to hold the position for three seconds, gently release and repeat 15 times for 3 times a day.

- **Pranayama:** The following pranayama exercises were done by the subjects twice a day 5 minutes each; Anuloma Viloma, Kapalabhati, Ujjayi Pranayama and Sitali Pranayama.

Participants were advised to stop the exercises if they suffer from dizziness, shortness of breath or excessive fatigue. The participants were trained to take their own oxygen saturation with the help of pulse oximeter, and a patient's diary was given to the participants to keep the account of their exercise schedule, oxygen saturation (pre and post exercise) and also to keep an account of any discomfort during exercises.

Data analysis

Demographics and baseline characteristics of participants were collected. The primary outcomes were change in oxygen saturation from baseline to end of study and improvement in distance covered during 6MWT. Measurement data was expressed as mean ± standard deviation. Continuous variables were compared using independent sample t test. Statistical significance was taken as $p<0.05$.

RESULTS

A total of 50 male subjects were included in the study. Study participants were between the ages of 31.5 to 45 years (mean ± SD- 39.77 ±3.15). Mean BMI of the study participants was found to be 21.53 (Range 19.03 - 24.21). The baseline demographic data of study population is shown in the following table;

Table 1: Baseline demographics of study population

Parameters	Total n=50
Gender –Males (n/%)	50 (100%)
Age, years	39.77 ±3.15
BMI, kg/m^2	21.53 ± 1.21

Values are expressed as mean ± SD

Baseline evaluation of the patients included 6MWT where mean distance covered by the study participants was 467.66 ± 34.1 m. Measurement of oxygen saturation revealed no significant decrease after test (p=0.3); results are shown in the following table;

Table 2: Baseline 6 Minute Walk Test MWT assessment

Parameters	Values
Distance, m	467.66 ± 34.1
Pre-walk SPO_2 (%)	94.52 ± 0.78
Post-walk SPO_2 (%)	93.6 ± 0.88

Values are expressed as mean ± SD

The patients were followed up for 3 months and at the end they were subjected to 6MWT which showed significant improvement pre and post-walk oxygen saturation; the results are shown in the following table;

Table 3: 6 Minute Walk Test pre and post-walk oxygen saturation

	Baseline	End of 3 months	P value
Pre-walk SPO_2 (%)	94.52 ± 0.78	98.08 ± 1.24	0.001
Post-walk SPO_2 (%)	93.6 ± 0.88	97.76 ± 1.17	0.0002

Values are expressed as mean ± SD

The distance covered during the 6MWT was compared between baseline and end of 3 months and it was found to have significantly improved (p=o.ooo1). The results are shown in the following figure;

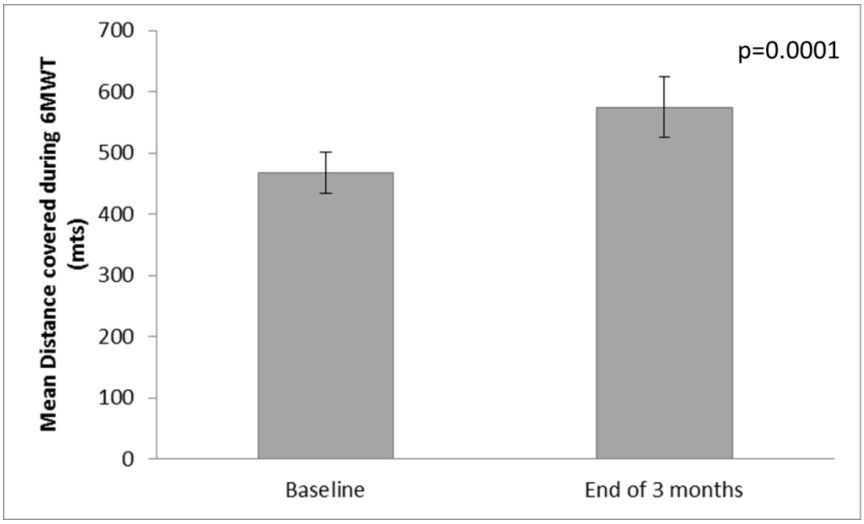

Figure 1: Change in distance covered during the 6MWT; p=0.001

Assessment of product of distance covered during 6MWT and weight of the participants also revealed a significant improvement at the end of 3 months of study; the results are shown in the following figure;

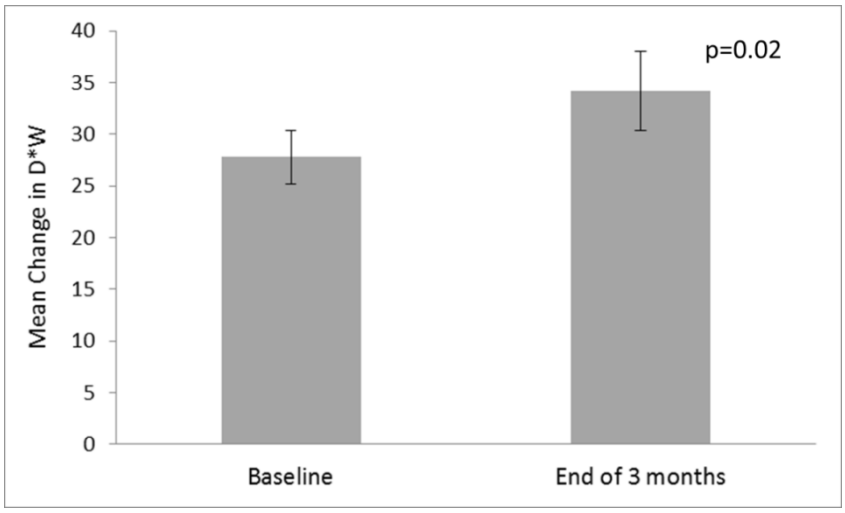

Figure 2: Change in product of distance covered during the 6MWT and weight; p=0.02

The participants also were clinically better. Symptoms like exhaustion, shortness of breath were lessened, although the study did not include any specific scale to assess the symptoms, Subjects also shared their positive experience regarding betterment in the mental health.

DISCUSSION

Research suggests that nearly one third of COVID-19 patients may develop acute respiratory distress syndrome (ARDS) and severe pulmonary complications which often leads to impairments in pulmonary function and physical performance of the survivors.[10] In patients with severe and critical COVID-19 courses, the impairment is more severe[11] and studies have shown that patients with acute deteriorations of pulmonary function do benefit from Pulmonary Rehabilitation.[12] However, research on effects of pulmonary rehabilitation in post-COVID-19 patients is scarce. Our study aimed at evaluating the effect of pulmonary rehabilitation in terms of breathing exercises and incentive spirometry in such patients. Assessment was done by the 6 Minute walk-test which is a simple tool that helps to evaluate the presence of silent or latent hypoxia and the discharge preparedness of patient. Thus, it has immense clinical applicability to ensure safe care of COVID 19 patients.[13] The product of walking distance and body weight (D*W) mimics the work of walking and can be effectively used as a parameter for evaluation of patients' fitness if gas exchange measurements are not available.[14] Pulmonary rehabilitation has been evaluated for its effect on recovery of pulmonary function in post COVID-19 patients. Spielmanns et al conducted a study in 99 post COVID patients admitted to the pulmonary rehabilitation centre also assessed the effect of pulmonary rehabilitation on pulmonary function and quality of life.[15] Puchner et al studied a subgroup of 26 post COVID patients who underwent an individualized, multi-professional rehabilitation after severe to critical infection.[16]

Study population in our study were otherwise healthy young males in the age group of 31.5 to 45 years. In study conducted by Spielmanns et al, the participants were elderly (mean age ± SD; 67.7 ±10.23) with male female ratio of 6:4.[15] The participants had mean age of 57 (SD±10) years and 70% were males in the study conducted by Puchner et al.[16] The diversity of the age of participants may indicate the fact that COVID affected people of all age groups. The mean BMI was 21.53 ± 1.21 in our study whereas in other studies it was relatively higher; 28.21± 6.11 and 27±4 and other comorbid conditions.[15],[16] Breathing exercises such as diaphragmatic breathing exercises and egmental chest expansion exercises are known to improve ventilation,

promote airway clearance, improve the strength, endurance & coordination of the muscles of ventilation, promote relaxation and relive stress. Senthil S et al has done virtual chest physiotherapy (diaphragmatic deep breathing, chest mobility exercises) on a COVID positive patient and found an improvement in the chest expansion and have highly recommended the chest physiotherapy to be commenced in home quarantine positive patients also.[17] Adbullahi et al in their study demonstrated the beneficial role of chest physiotherapy (diaphragmatic breathing, respiratory exercises, cough training) in the post COVID patients who have shown improvement in forced vital capacity (FVC), forced expiratory volume during first second of forced breath (FEV1), diffusing lung capacity for carbon monoxide, endurance and reduction in stress.[18] The study done by Grzegorz et al, evaluated the effect of slow and deep breathing to subjects who were exposed to high altitude and found increased oxygen saturation in the participants, concluding that slow and deep breathing increases SpO2 in hypoxic patients.[19] The case study report of Kirby P Mayer on the post COVID woman, has documented the beneficial effects of diaphragmatic breathing, aerobic training, which was done for duration of 8 week. The work has described the beneficial role of physiotherapy on exercise tolerance (significant improvement in all parameters of assessment of 6-minute walk test), anxiety as well as cognitive functions.[20] Our study also evaluated the beneficial effects of breathing exercises and found that it significantly improved SPO2 and distance covered during 6MWT. Pranayama involves controlled breathing exercises and isometric contraction of respiratory muscles which helps in strengthening of the respiratory muscles and increasing their endurance. Studies done by Angesh et all on the effect of pranayama on respiratory endurance has revealed that regular practice of breathing results in significant improvement in breath holding time, 40mm Hg endurance.[21] The work done by Vrinda Gokhale et al, has also shown in their study that Kapalbhati Pranayama results in better oxygen saturation where the subjects were made to perform Kapalbhati and oxygen saturation was measured by pulse oximeter.[22] Thus, knowing the utility of Pranayama from previous studies done on normal subjects as well as on patients with respiratory disorders, our study has utilized the past experience of these research work and implemented Pranayama on our study participants, the positive effects have further strengthened the implication of breathing exercises in recovery from respiratory illness especially where there is low lung compliance. The study on Sudarshan kriya yoga on COVID patients also narrates the potential therapeutic benefits that Sudarshan kriya yoga can offer to the population during this pandemic.[23] Incentive spirometry is a lung expansion technique used to promote sustained maximal inspiration, which is proposed to help patients by improving ventilation/perfusion mismatch and alveolar-PaO2 gradient. These effects reduce intrapulmonary shunting and the risk of atelectasis.[9] Incentive spirometry is commonly used for pre- and post-operative patients, as well as patients with pneumonia, acute chest syndrome, COPD exacerbations, and ARDS. Patients with COVID-19-related ARDS (CARDS) demonstrate a phenotype of ARDS with preserved lung compliance which involves decreased PaO2:FiO2 ratio due to intrapulmonary shunting and such patients were benefitted from proning. Similar reduction in ventilation/perfusion mismatch via splinting and preventing alveolar collapse is seen with incentive spirometry.[24] With experience from the past studies, we hypothesize that incentive spirometry should be considered as part of treatment protocols for patients with mild-to-moderate COVID-19 due to its theoretical benefits and limited risk and found that patients were

benefited by including incentive spirometry as a part of pulmonary rehabilitation. The subjects did not complain of shortness of breath, fatigue suggesting clinical improvement. The subjects were able to carry out their routine activities without any discomfort. The significant improvement in SpO2 also gave a feeling of well-being to the study participants. Thus, not only physical refinement but the cooperation and dedication of the study participants have let to enormous soundness in their mental health suggesting that breathing exercises, pranayama are cost effective treatment strategies that not only reduce the physical ailments but contribute to mental health as well**.** The limitations of the study included small sample size, open, single group study design, and lack of data of pulmonary function tests. Thus larger, controlled studies are warranted to confirm the efficacy of physiotherapy and breathing exercises in patients affected by COVID-19.

CONCLUSION:

Primary management of COVID 19 pandemic includes vaccination, antiviral therapy and immunomodulation. However, some cost effective complementary alternate therapies including chest physiotherapy, yoga and breathing exercises may provide additional benefits as seen in our study. Thus, breathing exercises must be intervened as a part of treatment as early as possible in COVID -19 patients.

Financial support and sponsorship: None

Conflicts of interest: None

Ethical approval: Ref No

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