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Effect of Pulmonary Rehabilitation on Exercise Capacity in Post Hospitalized Covid-19 Patients: An Experimental Study

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ABSTRACT

Introduction: COVID-19 is a systemic disease; the lungs are most commonly affected, with histopathological findings that may include diffuse alveolar epithelium destruction, capillary damage or bleeding, hyaline membrane formation, alveolar septal fibrous proliferation, and pulmonary consolidation.

Method: This study was designed as experimental, randomized double-blinded study. Participate divided into two groups- the pulmonary rehabilitation group (Group A) and control group (Group B). The inclusion criteria were patient with confirmed case of infection of COVID-19 was defined by RT-PCR assay on nasopharyngeal swab; aged 20 to 55 years; Hospitalised due to severity of covid-19 symptoms, persistent high grade fever>100^0 F, breathlessness, increase in dry cough), ≥3 months after any hospital discharge related to COVID-19 infection, regardless of need for critical care or ventilator support., Any persistent sequel of COVID- 19. All participants were explained the study protocol and they were enrolled in protocol after their written consent for this study. 6 minute walk test (6 MWT) was taken before and after the study protocol. Within group analysis using Wilcoxon signed Rank test. Between group analysis using Mann-Whitney Test. Level of significance was kept at $p<0.005$.

Results: Within group analysis showed statistically significant difference in Group A ($Z=-5.076$, $p=0.0001$) whereas no statistically difference in Group B ($Z=-2.160$, $p=0.078$). Comparison of end of 8 weeks intervention data which shows that there is statistically significant difference in both the groups ($U=45$, $p=0.001$)

Conclusion: Pulmonary rehabilitation is possible and effective therapeutic strategy to improve the aerobic capacity and improve quality of life post-hospitalized COVID-19 patients.

Keywords: COVID-19, Pulmonary Rehabilitation, Aerobic capacity

INTRODUCTION

At the end of 2019, a novel corona virus was identified as the cause of a cluster of pneumonia cases in Wuhan, a city in the Hubei Province of China. It rapidly spread, resulting in an epidemic throughout China, followed by an increasing number of cases in other countries throughout the world. In February 2020, the World Health Organization designated the disease COVID-19, which stands for corona virus disease 2019. The virus that causes COVID19 is designated severe acute respiratory syndrome corona virus 2 (SARS-CoV-2); previously, it was referred to as 2019-nCoV.[1]

Patients with severe COVID-19 experience a considerable amount of morbidity during hospitalization. Many of these deficits including lethargy, breathlessness, diffuse myalgias and cognitive dysfunction may remain post recovery from acute illness. Approximately 50% of the patients with severe COVID-19 require rehabilitation following hospital discharge.[2]

Pulmonary rehabilitation (PR) is one of the most effective management strategies to improve shortness of breath, health status, and exercise tolerance of patients with COPD. It also leads to a reduction in

symptoms of anxiety and depression. The 2013 American Thoracic Society (ATS)/ European Respiratory Society defines pulmonary rehabilitation as a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies which include, but not limited to, exercise training, education, and behavior change, designed to improve the physical and emotional condition of people with chronic respiratory disease and to promote the long term adherence to health enhancing behaviors.[3]

While COVID-19 is a systemic disease, the lungs are most commonly affected, with histopathological findings that may include diffuse alveolar epithelium destruction, capillary damage or bleeding, hyaline membrane formation, alveolar septal fibrous proliferation, and pulmonary consolidation. A decline in the TLC (Total lung capacity) and reduction in exercise capacity in COVID-19 has been seen in early convalescence phase.[2]

Aerobic capacity is defined as the maximum amount of physical exertion that a patient can sustain, improves the function of immune and respiratory systems in patients with COVID-19 Patients.[4] 6 minute walk test (6MWT) is a clinical assessment tool for functional exercise capacity in patients with severe pulmonary disease. The present study aims to the effects of pulmonary rehabilitation on lung function on post hospitalized COVID -19 patients.

MATERIALS & METHODS

This study was designed as a randomized controlled, double-blinded study. Source of data collection were from various hospitals from Ahmedabad from 2020.

Patients who agreed to participate in the study were divided into two groups - as the pulmonary rehabilitation group (Group A) and control group (Group B) - using chit-prick randomization method. The outcome measures were assessed before and end of the 8 weeks of interventions. All participants were informed about assessment and intervention procedure and written consent forms before research involvement. In case of refusing to continue with any reason and in any stage, the participant and relevant information were excluded from final analysis.

Inclusion and exclusion criteria:

The inclusion criteria were patient with confirmed case of infection of COVID-19 was defined by RT-PCR assay on nasopharyngeal swab; aged 20 to 55 years; Hospitalised due to severity of covid-19 symptoms (decrease in spo2-below 90%), persistent high grade fever>100^0 F, breathlessness, increase in dry cough), $\geq$ 3 months after any hospital discharge related to COVID-19 infection, regardless of need for critical care or ventilator support., and Any persistent sequelae of COVID- 19. Exclusion criteria were who have Heart rate > 100 beats/minute, blood pressure < 90/60 mmHg or > 140/90 mmHg, blood oxygen saturation 95%, Other diseases in which exercise is unsuitable, Co morbidities, Direct lung trauma, Injuries to other organs and systems due to COVID-19, Any complication after COVID-19 (ARDS), Sepsis or sepsis shock, multiple organ failure, acute kidney injury, cardiac injury, Patients who might need further isolation by doctor, patients unable to take deep breath effectively due to pain or diaphragmatic dysfunction.

Outcome measure:

6 minute walk test (6 MWT):

Each individual performed 6 MWT to assess the aerobic capacity. This is moderate to high-intensity test is valid for assessing aerobic capacity. Subject should rest for approximately 10 minutes before starting the test. Measure the baseline heart rate and oxygen saturation, baseline dyspnea by using the Borg scale. Set the lap counter and timer. Provide the patient with detailed instructions on how to proceed during the test. The patient is then positioned at the starting line and allowed to walk unassisted once the test begins. As each minute passes, the patient should be informed of the time

left to complete the test and encouraged to continue. At the end of the test, record the Borg dyspnea, check heart rate and oxygen saturation, the number of laps from the counter or marks on the worksheet, and total distance walked.[5] All participants were explained the study protocol and they were enrolled in protocol after their written consent for this study. Outcome measure was taken before and after the study protocol.

Intervention: Study duration: 8 WEEKS

3sessions / week

Group A Protocol for pulmonary rehabilitation: 8 weeks total duration

Pulmonary rehabilitation

1. Inspiratory muscle training if inspiratory muscles are weak.
2. Diaphragmatic breathing (5 times)
3. Thoracic expansion (with shoulder elevation) (5 times)
4. Mobilisation of respiratory muscles if needed.
5. Airway clearance techniques (ACBT) if patients complain of dry cough.
6. Paced breathing exercises if needed.
7. Positioning to relive breathlessness and maintain oxygenation (5 min.) if needed.
8. Pursed lip breathing exercise.
   According to patients' strength and perceived exertion (borg dyspnea scale) the functional rehabilitation would be started.

Functional rehabilitation

1. Upper limb and lower limb free exercises (10 repetitions for all major muscle group.
2. Active limb exercises should be followed by progressive muscle strengthening (suggested programs 8-12 RM load for 8 -12 repetitions, 1 to 3 sets with 2 minutes rest between sets, 3 sessions a week for 6 weeks.
3. Endurance training, strength training (resisted exercises) for upper limb and lower limb addition with walking exercises would be given.

The total duration of exercise will be 3 sessions per week for at least 20 minutes/session.

Aspects to monitor closely in patients include[6]

1. Shortness of breath
2. Decreased SaO2 (<95%)
3. Blood pressure (< 90/60 or > 140/90)
4. Heart rate (>100 beats per minute)
5. Temperature (> 37.2 C)
6. Excessive fatigue
7. Chest pain
8. Severe cough
9. Blurred vision
10. Dizziness
11. Heart palpitations
12. Sweating
13. Loss of balance
14. Headache

Patient education

1. Explain the importance of respiratory rehabilitation
2. Healthy lifestyle education
3. Encourage patients to participate in family and social activities.

GROUP B (control group):

Group B was kept in a waiting period and asked to continue their routine activities. The subjects were asked to follow up every week. They were assessed for Aerobic capacity. Post test was conducted after a period of 8 weeks. Following outcome measures were taken for the both groups.

STATISTICAL ANALYSIS

Data analysis was done using Statistical package for the social sciences (SPSS) version 20 and Microsoft Excel 2019. Prior to statistical tests, the data was screened for normality. Shapiro-Wilk test was used to check normality. Data of all the outcomes were not normally distributed in both groups so non-parametric test was used for analysis. Within group analysis of the

difference in 6 MWT group A and group B was done using non-parametric test ─ Wilcoxon signed Rank test. Between group analysis of the difference in 6 MWT in group A and group B was done using nonparametric test ─ Mann-Whitney Test. The tests were applied at 95% confidence interval on p-value set at <0.05.

RESULT

155 subjects having confirmed COVID-19 case were screened. 130 fulfilled the inclusion criteria and were recruited for the study. Thus 30 dropped out from the study and remaining 100 (50 in intervention group + 50 in control group) completed the treatment protocol.

The mean age of the subjects in group A was 35.9 ± 8.68, in group B was 39.7+ 5.45. In Group A male was 26 and female were 24 whereas Group B male were 22 and female were 28.

Within group analysis showed statistically significant difference in 6 MWT [Table 1]

Group	Pre-treatment	Post-treatment	Z value	p value
Group A	578.4 ± 117.84	670.6 ± 52.58	-5.076	0.0001
Group B	583.6 + 134.12	588.8+111.36	-2.160	0.078

Table 1: Within group analysis in both groups

Comparison of baseline data which shows that there is no significant difference in both the groups [Table-2]. Comparison of end of 8 weeks intervention data which shows that there is statistically significant difference in both the groups [Table 3].

Outcome measure	Group A (Mean ± SD)	Group B (Mean ± SD)	U value	P value
6 MWT	578.4 ± 117.84	583.6 + 134.12	97	0.483

Table 2: Comparison of baseline data of both the groups

Outcome measure	Group A (Mean ± SD)	Group B (Mean ± SD)	U value	P value
6 MWT	670.6 ± 52.58	588.8+111.36	45	0.001

Table 3: Comparison of end of 8 weeks intervention data of both groups

DISCUSSION

In present study found that 6 MWT mean of 578.4 meters to 670.6 meters which was found significant (p = 0.0001) in group A. No statistically significant difference was seen in group B (p =0.078). A systemic review and meta analysis suggest that Pulmonary rehabilitation improve exercise capacity measured by 6-MWT among patients with mild-to-moderate lung impairment after COVID-19.[7] In patients [8]

Between Group analysis, 6 MWT (distance) was found significant improvement in group A (Pulmonary rehabilitation group) compared to Group B (Control group) with p =0.001. Ahmed I et al found that pulmonary rehabilitation program is superior to no intervention in improving dyspnea, exercise capacity, lung functions, and fatigue in patients with COVID-19. with COVID 19, the arterial hypoxemia can be induced by intrapulmonary shunting, impaired lung diffusion, deregulated hypoxic pulmonary vasoconstriction and formation of intravascular micro thrombi. However, with exercise for 8 weeks there are changes in the muscle physiology and the oxygen diffusing capacity which led to reduction in the desaturation levels in patients and improved aerobic capacity in COVID-19 patients.

Pulmonary rehabilitation appears to be safe and beneficial for both acute and chronic COVID-19 patients. Pulmonary rehabilitation has a significant effect on improving physical function, pulmonary function, dyspnoea, anxiety, depression, physical activity intensity level, and sleep quality.[9]

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pulmonary function, dyspnoea, anxiety, depression, physical activity intensity level, and sleep quality.[10]

Limitation of present study was descriptive multivariate analysis was not done.

CONCLUSION

Pulmonary rehabilitation is possible and effective therapeutic strategy to improve the aerobic capacity and improve quality of life post-hospitalized COVID-19 patients.

Declaration by Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest.

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