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Effect on Lung Function by Pulmonary Rehabilitation in Post-Hospitalised COVID-19 Patients

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ABSTRACT

Aim: to find out effect on lung function by pulmonary rehabilitation on post hospitalized covid -19 patients.

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; Hospitalized 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. Lung function 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: In Group A, mean and SD for $FEV_1$for Pre test was 116.58 ± 25.03 and for post test was104.32±14.60. The P value was<0.001which shows that the intervention was effective. The Mean and SD for FVC for PreTest102.96±22.39and for post test was96.88±19.07. The P value was <0.001 which shows that the intervention was effective. Mean and SD for FEV1/FVC for Pre Test 113.84 ± 11.25 and for post test was 109.40 ± 15.04. The P value was 0.024 which shows that the intervention was effective.

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

Keywords: COVID-19, Pulmonary Rehabilitation, Lung function test

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. [1,2]

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.[3]

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 behaviours.[4]

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[5]

Exercise capacity is denoted as the maximal amount of physical exertion that a patient can maintain and that improves the function of immune system and respiratory system in patients

suffering from COVID-19. This all the contribution to the widely spread spectrum of pathogenetical mechanisms that can be triggered by SARS-CoV-2 condition with cytokine storm, inflammatory processes and coagulation cascades in blood vessels. In this type of similar retrospective study, they showed Higher CRP values (48.61±30.20 mg/L) were observed in majority patients as a part of the epidemiological and clinical characteristics of COVID-19.[6] so present study aim to find out effect on lung function by pulmonary rehabilitation 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 week 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), ≥ 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:
Intervention:
Study duration: 12 WEEKS
3sessions / week

Group A: Protocol for pulmonary rehabilitation: 12 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:

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 lung function. [viii] 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. Group A and group B was done using non-parametric test - Wilcoxon signed Rank test. Between group analysis of the difference PFT 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

Data of 100 patients were analyze during Statistical Package for Social Sciences version26 (SPSSv.26) and Microsoft Excel 2013.100 patients, after screening, were divided into two groups.50 patients in Group A were administered Respiratory and

Functional rehabilitation and50 patients in Group-B were administered conventional therapeutic exercises.

All the 50 patients in each group completed the study and data analysis was performed.

The Mean age of individuals in the study for Group A is 35.32Years with Standard Deviation of 8.46 Years whereas for Group B Mean age is 29.10 Years with Standard Deviation of 5.26 Years. In Group A (Experimental Group) the Mean Height is 163.86 Cms with Standard Deviation of 7.21Cms. Group B (Control Group) Mean Height is 161.04 Cms with Standard Deviation of 6.06 Cms. The Mean Weight in Group A is 71.20Kg with SD of 11.95 Kg while for Group B Mean Weight is 60.46 Kg with SD of 7.61Kg.

GROUP			POSTFEV1	PREFVC	POSTFVC	PREFEV1/FVC	POST FEV1/FVC	PREPEFR	POSTPEFR
GROUPA	N		50	50	50	50	50	50	50
	Mean		104.32	102.96	96.88	113.84	109.40	72.58	78.56
	Median		103.00	101.00	95.00	115.00	108.00	79.00	80.00
	Std.Deviation		14.60	22.39	19.07	11.25	15.04	25.15	17.65
	Quartiles	1st	94.50	83.00	80.00	105.00	99.00	46.00	66.00
		3rd	112.75	118.00	112.50	125.00	120.00	89.00	90.00
GROUPB	N		50	50	50	50	50	50	50
	Mean		81.96	86.96	87.60	43.56	51.44	110.12	107.58
	Median		81.00	90.00	83.00	46.00	48.50	114.50	111.00
	Std.Deviation		23.13	16.82	25.39	10.62	14.83	13.58	12.55
	Quartiles	1st	67.75	75.00	71.00	37.75	41.00	103.00	101.25
		3rd	93.00	96.00	96.00	48.00	62.25	120.00	115.00

Baseline characteristics table showing Lung function test parameters of Group A and Group B Within the group analysis of Group A

Pulmonary Lung Function

Parameter	Mean	Std. Deviation	Wilcoxon Test	PValue
PRE FEV1	116.58	25.03	4.928	<0.001
POST FEV1	104.32	14.6		
PRE FVC	102.96	22.39	4.012	<0.001
POST FVC	96.88	19.07		
PRE FEV1/FVC	113.84	11.25	2.251	0.024
POST FEV1/FVC	109.4	15.04		
PRE PEFR	72.58	25.15	3.558	<0.001
POST PEFR	78.56	17.65		

DISCUSSION

In Group A, Mean and SD for FEV1 for Pre Test was116.58±25.03and for post test was104.32 ±14.60. The P value was <0.001 which shows that the intervention was effective. The Mean and SD for FVC for PreTest102.96±22.39 and for post test was96.88±19.07. The P value was <0.001 which shows that the intervention was effective. Mean and SD for FEV1/FVC for Pre Test 113.84 ± 11.25 and for post test was 109.40 ± 15.04. The P value was 0.024 which shows that the intervention was effective.

The Mean and SD for PEFR for Pre Test 72.58±25.15 and for post test was78.56±17.65. The P value was <0.001 which shows that the intervention was effective. 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.

Functional characteristics in lungs and functional characteristics of a restrictive pattern in Pulmonary Function Tests (PFTs) include decreased TLC and forced vital capacity (FVC). The latter parameter is the maximum amount of air exhaled after a maximal inhalation and depends on the elasticity of the lung tissue, the anatomy of the thoracic cage, and the function of the respiratory muscles.

In restrictive diseases, the forced expiratory volume over 1 second (FEV1) usually decreases or stays normal, and the ratio of FEV1 to FVC is generally preserved or increased. These alterations in pulmonary dynamics can be compensated by an increased respiratory rate, with hypercapnia developing only at later stages of the disease. The functional data are different from those observed in obstructive diseases in which TLC and FVC are normal (80 -120% of predicted) or increased, while the significant

figure is the decrease in the FEV1compared to FVC[9].

Pulmonary rehabilitation is safe, beneficial for both acute and chronic COVID-19 affected individuals. Pulmonary rehabilitation has a significant effect on improving physical and pulmonary function, dyspnea, anxiety, depression, physical activity intensity level and sleep quality.[9]

The reduced compliance in covid-19- The intrinsic pulmonary restriction is most commonly seen by inflammation of the pulmonary parenchyma with deposition of collagen in the interstitium, which further leads to pulmonary fibrosis.

This progressive fibrosis thickens the alveolar septae, forcing a physical barrier to gas exchange.

Lung compliance is independent of the thoracic cage, it has a semi rigid covering, but lung and thorax are systems arranged in series. At last, both these structures are the sum of compliances of respiratory system. Similarly, a systematic review, (meta-analysis) reported superior effects of breathing exercise on lung function parameters (FEV1 and FEV1/FVC) as compared with control for COPD.[10]

Peak expiratory flow rate showed significant improvement in group A as respiratory muscle function helps to improve the strength as a result of exercise training programme. Inside the lungs the maximum inflation and deflation process helps to maintain the strength of respiratory muscles, the reason for this strengthening is physiological trigger for the release of surfactant and prostaglandin (PG) E2 into the alveolar spaces, which in turn improves the lung compliance and reduce the tone of bronchial smooth muscles.[11]

Pulmonary rehabilitation includes breathing exercises diaphragmatic breathing exercise, purse lip breathing exercises etc. helps in inspiratory capacity, improves lung compliance and recruits collapsed alveoli. Inspiratory hold helps collateral ventilation, spirometer improves lung expansion helps in increasing lung capacities[12].

In between group comparisons, the difference between pre-test and post-test values were calculated and Man Whitney test was used to compare the difference between two groups – Group A and Group B.

For FEV1 t with a P value is <0.001, considered significant. Hence there is significant difference between the two groups in FEV1.FEV with a P value is 0.010, considered significant. Hence there is significant difference between the two groups in FEV. For FEV1/FVC with a P value is <0.001, considered significant. Hence there is significant difference between the two groups. Also for PEFR the P value is <0.001 had significant difference between the two groups. Elisabetta Zampogna et al in their study did a recollective data analysis of patients recovering from COVID-19,those who required assisted ventilation support or oxygen therapy, and who were admitted to an in patient pulmonary rehabilitation program has stated that pulmonary rehabilitation program includes type, intensity, timing, and modality of intervention were designed for the individual patient.[13] Their physical, cognitive, and emotional problems were associated to prolonged duration of mechanical ventilation. Pulmonary rehabilitation was possible and the most effective in patients recovering from COVID 19, including those who required assisted ventilation or oxygen therapy.

Limitation of study: samples were restricted to Ahmedabad city., Occupation was not included in inclusion criteria.

CONCLUSION

The study concluded that when the Pulmonary rehabilitation (Diaphragmatic Breathing, Pursed lip Breathing, thoracic expansion exercises etc.) and functional rehabilitation (upper limb, lower limb free exercises, endurance training and strength training etc.) regime for 8 weeks, when given in post hospitalized Covid-19 individuals, it was found that pulmonary rehabilitation improved the lung capacity, in post hospitalized Covid-19 individuals. The

structured rehabilitation (respiratory and functional) allowed the individuals affected with Covid-19 to go back the society promptly.

Declaration by Authors

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