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Effect of Pulmonary Telerehabilitation on Functional Capacity in COVID Survivors; An Initial Evidence

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ABSTRACT

Objective: This retrospective case series is to see effect of pulmonary telerehabilitation on functional capacity in covid-19 survivors

Methods and materials: 10 (8 males, 2 females) participants were selected in this study based on inclusion criteria of post covid-19 survivors with respiratory system involvement, who underwent minimum 6 weeks of pulmonary telerehabilitation at least 3 days per week. Pulmonary telerehabilitation was given in the form of breathing exercises, incentive Spirometer, variety of aerobic and strengthening exercises, and patient education. Pre and post 6 weeks rehabilitation outcome measures of visual analogue scale (VAS) for fatigue, SPO2 using pulse oximeter, single breath count, one minute sit to stand test and one minute squat test were noted.

Statistics and results: The descriptive statistics were done. According to the normality analysis Wilcoxon sign rank test was assigned to non parametric data and Paired t test was assigned to parametric data. A p value of < 0.05 was considered significant.

Comparison between pre and post rehabilitation showed statistically significant changes in one minute sit to stand test ($p=0.005$), one minute squat test ($p= 0.007$), resting SPO2 ($p=0.025$), post exercise SPO2 ($p=0.003$), post exercise VAS for fatigue ($p=0.017$). No statistically significant difference was seen in the single breath count test ($p= 0.415$). Also, resting, post exercise SPO2 and VAS for fatigue showed clinically significant changes with large effect size.

Conclusion: Pulmonary telerehabilitation shows statistically and clinically significant improvement in functional capacity in COVID survivors.

Keywords: Pulmonary rehabilitation, telerehabilitation, Covid survivors, functional capacity

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a potentially severe acute respiratory infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). [1] The Clinical presentation is that of a respiratory infection with a symptom severity ranging from a mild common cold-like illness, to a severe viral pneumonia leading to acute respiratory distress syndrome that is potentially fatal. It is observed that COVID survivors have experienced severe limitation in their functionality and poor quality of life even several weeks after the active infection. [2]

Functional capacity refers to the capability of performing tasks and activities that people find necessary or desirable in their lives. The assessment of functional capacity reflects the ability to perform activities of daily living that require sustained aerobic metabolism. [3]

The selection of an appropriate exercise test protocol for assessing

functional capacity is of critical importance, especially when aerobic capacity is to be estimated from exercise time or peak work rate. A frequent consideration in the assessment of functional capacity, especially in nonclinical settings, is whether to perform maximal or submaximal testing. Although maximal testing provides the only accurate determination of aerobic capacity, submaximal testing may be desirable in several situations. [3]

In recent years, research has begun to investigate the development of alternative tests that are simpler and easier to conduct. The 1-min STS test has potential as an important predictive tool, having shown predictive validity as a strong and independent predictor of mortality and health-related quality of life (HRQoL) in respiratory patients. [4]

The single-breath counting test is a valid and repetitive technique, and may be an important screening option for assessment of lung function in the absence of specific equipment. This technique opens perspectives to replace slow vital capacity measurement in hospitals, which lack spirometric equipment, or in patients who may have a contagious disease, which has a risk of contamination and spread of disease from one patient to another. [5]

For practical purposes, the common test modes of field tests are stepping and walking tests. Though step test & walk test appears to accurately estimate cardiopulmonary fitness in younger & older adults, it is argued that while performing stepping movements might cause musculoskeletal problems in lower limb as well as increase the fall risk to mobility-limited specially to older adults, additionally spacious walkway needed to perform walk test which again might be the limitation for performing the test. [6] Hence researchers have developed a squat test that is simple to administer in a confined space with minimum apparatus.

Pulmonary rehabilitation (PR) refers to the individualized rehabilitation treatment of patients having acute or chronic lung injury. The goal of Pulmonary Rehabilitation is not only to improve the patient's physical and mental conditions but also to help the patient return to family and society more promptly. The benefits include improved exercise tolerance, and quality of life in patients undertaking Pulmonary Rehabilitation.

Several high-quality clinical studies have verified the benefits of pulmonary rehabilitation for inpatients, out patients, and in home patients. The benefits include improved exercise tolerance in patients with chronic pulmonary diseases, reduced number of hospital admissions and length of hospital stays, enhanced health-related quality of life, improved respiratory muscle function and relieved dyspnea, alleviated disease-related anxiety and depression, and enhanced skeletal muscle function of upper and lower limbs. [7]

As per the recent evidence, a person is expected to have significant respiratory, physical and psychological impairment following the acute phase of COVID-19, and it is recommended that a huge number of patients should be referred early to a rehabilitation programme.

Telerehabilitation refers to providing rehabilitation services using electronic communication technologies. This pandemic has elicited everyone around the globe to think of various options to help the patients without compromising the social distancing protocol. Also the limited number of OPDs being functional becomes the mainstay to control the contact and thereby the infection. This limits the access and availability to patients for routine ways of patient care. India, being a country with a population contributing to 17.7% of the total world population, new measures to reach out to patients are essential. Early assessment and intervention should be available to these patients who are dealing with the Post COVID syndrome. With telerehabilitation, patients can receive prescription and follow up for medicine, exercise & counseling for psychological stabilization without visiting the hospital

thus eliminating the mutual fear of contacting the disease through otherwise possible contact. Since there is no actual physical contact, there is no need of use of protective equipment by the treating therapist during telerehabilitation sessions. This is likely to make more effective and natural human interaction possible thereby enhancing patient satisfaction and effective treatment delivery and outcome with no additional stress to the patient as well as to the treating therapist. [8]

MATERIALS AND METHODS

This is a retrospective case series done on patients referred to cardiopulmonary department of KJ Somaiya College of Physiotherapy in the month of May to August 2020 who were post covid-19 survivors with respiratory system involvement, who underwent minimum 6 weeks of pulmonary telerehabilitation at least 3 days per week. Non Covid respiratory disease patients and Covid patients without respiratory system involvement, also those who could not complete minimum 6 weeks of pulmonary telerehabilitation were excluded from the study. Convenience sampling method was used and 10 subjects were included In the study. (n=10) (8 males, 2 females). Online consent was taken from the patient before starting pulmonary telerehabilitation.

Pulmonary telerehabilitation was conducted on an individual basis with each patient through video calling the patient using mobile phone or laptop. This included

1. Breathing exercises.
2. Incentive spirometer where ever available.
3. Warm up phase including range of motion exercises of all joints.
4. Aerobic exercises including spot marching, spot jogging, arm circles, jumping jacks, walking wherever available and permitted etc.
5. Strengthening exercises for upper limb with filled water bottle, wall push ups; for lower limb squatting, lunges, dynamic quadriceps etc.
6. Cool down phase including range of motion exercises or slow walking.
7. Patient education and energy conservation advice.
8. Active cycle of Breathing Technique/ Autogenic Drainage if a patient complained of difficulty in secretion removal.

Exercises were gradually added and intensity was increased as per patient response and capacity on individual basis.

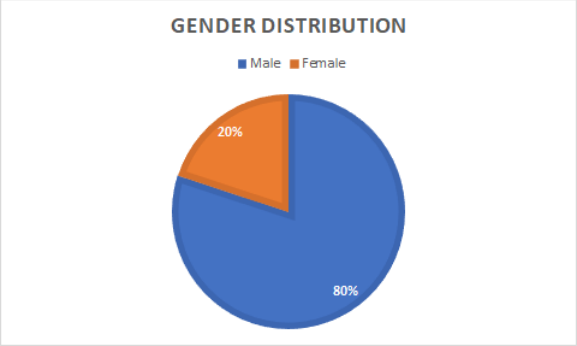
Pre and post 6 weeks rehabilitation outcome measures were noted which included visual analogue scale (VAS) for fatigue, SPO2 using pulse oximeter, single breath count, [9] one minute sit to stand test [10] (for cardiopulmonary endurance) and one minute squat test [11] (for lower limb muscular endurance)

Statistical Analysis:

The data was analysed using the computer software Microsoft Excel and Statistical Package of Social Sciences (SPSS) 19. The descriptive statistics were done. According to the normality analysis Wilcoxon sign rank test was assigned to non parametric data and Paired t test was assigned to parametric data. A p value of less than 0.05 was considered significant.

RESULTS

The study included a sample of 10 individuals of which 20% were female and 80% male as indicated in Chart 1.



Patients diagnosed with COVID-19 had comorbidities like hypertension and diabetes mellitus. The distribution of the same is as follows. However 4 out of 10 individuals

were not having any comorbidity. However amongst those with comorbidities that is amongst the 6 people 83.33% had diabetes and 50% had hypertension.

The comparison between pre rehab and post rehab groups for each outcome measure are as follows.

1. One minute sit to stand test:

	Number	Mean	Std Deviation	P value
Sit to stand pre	10	13.3	3.56	0.005
Sit to stand post	10	26.2	5.73	

As the groups did not have a normal distribution Wilcoxon Sign Rank test was used to analyse and a significant difference with p value of 0.005 was noticed.

2. One minute single breath count test:

	Number	Mean	Std Deviation	P value
Single Breath count pre	10	17.9	9.32	0.415
Single Breath count post	10	21.3	5.29	

No significant change was observed with rehabilitation in the pre and post values of the one minute single Breath count test as p value was found to be 0.415.

3. One minute squat test:

	Number	Mean	Std Deviation	P value
Squat test pre	10	13.2	6.89	0.007
Squat test post	10	24.8	10.17	

A significant change was seen in the number of squats an individual can do in a minute prior to rehabilitation and post rehabilitation. With significance of p at 0.007.

4. Oxygen saturation at rest pre rehabilitation and post rehabilitation.

Since the data was found to be parametric paired t test was used to analyse the difference. A significance of p 0.025 was established.

	Number	Mean	Std Deviation	P value	Effect Size
Pre rehab resting SPO2	10	95.6	2.11	0.025	1.15
Post rehab resting SPO2	10	97.5	0.971		

5. Post exercise oxygen saturation was analysed prior to and after the rehabilitation which showed a statistically significant change with p value of 0.003

	Number	Mean	Std Deviation	P value	Effect Size
Pre rehab post exercise SPO2	10	94.6	2.63	0.003	1.69
Post rehab post exercise SPO2	10	98	1.05		

6. In this study we also assessed the fatigue level experienced by the patients after the exercises prior to rehabilitation and post rehabilitation and again a statistically significant change was observed.

	Number	Mean	Std Deviation	P value	Effect Size
Pre rehab post exercise VAS	10	4.4	1.83	0.017	1.22
Post rehab post exercise VAS	10	2.4	1.42		

Also, for outcomes 4,5 and 6 a clinical significance was established using Cohen's d which showed a large difference in the effect size. Thus the difference in the outcomes was not only statistically significant but also had a clinically significant difference.

DISCUSSION

In the study conducted to observe the effects of pulmonary tele-rehabilitation on functional capacity in COVID-19 survivors, 10 patients were enrolled of which 80% were males and 20% females with the mean age 51.66± SD 12.45 years. .

It has been found that there is significant result in all the outcome measures (one minute sit to stand test, one minute squat test, SPO2 and VAS score for fatigue) except single breath count.

Single breath count is a simple clinical bedside parameter to monitor lung function. [12] In this study, the single breath count has increased from 17.9 to 22.3 but is statistically not significant. Exercise has an effect on the pulmonary system by increasing the lung volumes and capacity. Exercises given to all the patients were of mild intensity. Their baseline lung functions were affected due to the infection by COVID19, which improved with exercises over 4 to 6 weeks.

Being a validated measure of the functional outcome in COPD patients, the Sit To Stand test could also be considered a surrogate to the walking test. [13,14] As patients are homebound, it is difficult to do any form of exercise testing through telerehab. Hence, the simple test 1 minute sit to stand, was done among these patients. Advantages of this test during telerehab is, it is easy to demonstrate by the therapist and to monitor the parameters and it is a submaximal form of exercise, hence relatively more safe as compared to a maximal test. Parameters that were monitored before and after the rehab were heart rate and oxygen saturation through pulse oximeter. It was found that the scoring of sit to stand improved after 8 weeks of tele rehab in COVID survivors from 13.3 to 26.2, which was statistically significant ($p < 0.005$). Aerobic exercises along with resistance training among these patients must have led to physiological changes in the working muscles which would have led to improved scoring.

These patients were given lower limb strengthening exercises during their exercise sessions. This led to increase in the lower limb strength thereby improving the squat test score. The number of squats increased from 13 to 24 which was statistically significant. Females in the group changed the category from average to excellent, while males have shown an improvement and difference of two categories from their baselines which differs according to their age specific score. [11] Resistance training leads to a number of changes in the muscle fibres like change in the fibre type, muscle hypertrophy, increase in the cross sectional area. It has been found that giving resistance training at least twice a week is beneficial for muscle growth. [15] Increase in strength of lower limb muscles will also lead to an improved score of sit to stand test.

It has been seen that patients diagnosed with COVID 19 usually desaturate during the exercise session. In this study too, mean pre rehab saturation was 95.6% which increased to 97.5%. This was statistically significant with the p value 0.003.Also, their post exercise saturation was noted which improved from 94.6 to 98.6.During the initial days of rehabilitation these patients were desaturating very fast during the exercise session. Hence the interval breaks given were more. However, after a few sessions as the overall capacity of patients improved, they were desaturating less often.

It has been found that doing exercise for at least 30 mins, 3 - 4 times a week improves the oxygen saturation and heart rate in young adults. [16]

In patients with COVID 19, the arterial hypoxemia can be induced by intrapulmonary shunting,, impaired lung diffusion, dysregulated hypoxic pulmonary vasoconstriction and formation of intravascular microthrombi. [17] However, with exercise for 6-8 weeks there are changes in the muscle physiology and the oxygen diffusing capacity which led to reduction in the desaturation levels in these patients. One of the patients was on 5 litres of oxygen at the start of rehab and eventually over 8 weeks with the exercise program he was off oxygen.

Fatigue levels were assessed pre and post rehabilitation which showed statistically significant results with the p

value 0.017. On the numerical rating scale, the score reduced from 4.4 to 2.4. The reason for improvement could be due to improved strength, improved aerobic capacity, and reduced desaturation. Also, the breathing exercises given during the exercise sessions must have helped to reduce the fatigue scores.

It has been proven in COPD patients that breathing exercises help to reduce the fatigue scores. [18] By doing regular breathing exercises, there is a change observed in breathing pattern, thereby recruiting diaphragm more effectively. Hence, their breathlessness is reduced thereby reducing the fatigue levels.

Exercise through telerehabilitation has definitely been beneficial in COVID survivors. However, the study needs to be done on a larger number of patients.

CONCLUSION

Pulmonary telerehabilitation shows statistically and clinically significant improvement in functional capacity in covid survivors.

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